

III

SELF-ASSESSMENT PROBLEMS

This third and final section of the text is intended for self-assessment. Numerous review questions and practice examples are included based entirely on the material covered in Parts I and II. The review begins with a number of short-answer questions followed by actual ECGs for interpretation. Unless otherwise indicated, the ECGs have been standardized so $1\text{ mV} = 10\text{ mm}$.

QUESTIONS

1. The P wave represents _____ (two words).
2. The QRS complex represents _____ (two words).
3. The T wave represents _____ (two words).
4. The normal range of the PR interval in adults is between _____ and _____ second.
5. Lead V_1 is obtained by placing the chest electrode to the right of the sternum in the _____ intercostal interspace.
6. With hypocalcemia the QT interval _____.
7. A *delta* wave is seen in what syndrome?
8. Name three drugs that may prolong the QT interval.
9. Name three causes of low-voltage QRS complexes.
10. Name at least three arrhythmias associated with digitalis toxicity.
11. A wide rSR' complex in lead V_1 with sinus rhythm most likely indicates _____.
12. Name three ECG patterns that may be seen with acute pulmonary embolism.
13. If the P wave in lead aV_R is -2 mm and the P wave in lead aV_L is -3 mm , then what must the amplitude of the P wave in lead aV_F be?
14. Two factors that may potentiate digitalis toxicity are _____ and _____.
15. Digitalis (increases? decreases? has no effect on?) conduction of impulses through the AV node.
16. What metabolic or drug-related factor may prolong the QRS duration?
17. Prominent U-waves are often seen with what electrolyte abnormality?
18. Tall peaked P waves in leads II, III, and aV_F are suggestive of _____.
19. With normal sinus rhythm the P wave is virtually always negative in lead _____ and positive in lead _____.

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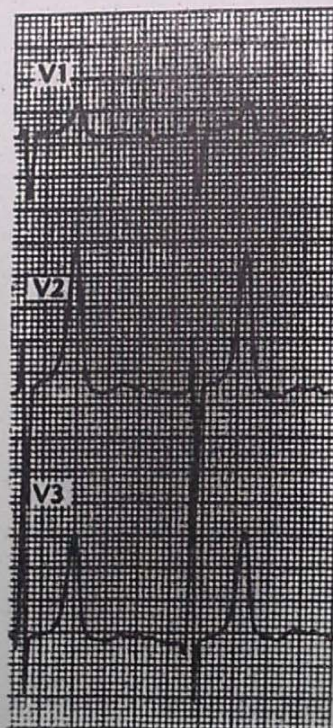
20. Draw the hexaxial diagram showing the six extremity (frontal plane) leads.
21. Normally the R/S ratio in lead V_1 (in adults) is less than _____.
22. Atrial fibrillation is sometimes seen in which endocrine disorder?
23. Name the three basic ECG patterns that may be seen in cardiac arrest.
24. Name three causes of sinus tachycardia.
25. Syncope associated with complete heart block or other profound bradycardias is called the _____ syndrome.
26. Define ventricular tachycardia.
27. Tall, peaked T waves are characteristic of which electrolyte disturbance?
28. Name three causes of ST segment elevations.
29. A patient experiencing typical angina pectoris with exertion may show what ECG pattern in lead V_5 as a sign of subendocardial ischemia?
30. Right bundle branch block is always a sign of serious organic heart disease (true or false).
31. Atrial fibrillation is always a sign of serious organic heart disease (true or false).
32. Left bundle branch block is often a sign of serious organic heart disease (true or false).
33. The *early repolarization* pattern is a normal variant (true or false).
34. Prinzmetal's angina is characterized by ST segment elevations (true or false).
35. With acute transmural *anterior* wall ischemia, leads II, III, and aV_F are likely to show reciprocal ST segment _____.
36. Wide (> 0.12 sec) P waves in lead II suggest _____.
37. Draw a QS complex.
38. A wide (> 0.12 sec) QS complex in lead V_1 with sinus rhythm is seen with _____.
39. Name five causes of ventricular ectopy.
40. A 20-year-old college student complaining of light-headedness and palpitations is found to have a regular tachycardia with normal QRS complexes at a rate of 190 beats/min without evident P waves. The arrhythmia terminates abruptly during carotid sinus massage. What is the most likely diagnosis?
41. A patient is found to have a pulse rate of 35 beats/min. The ECG is most likely to show one of five basic classes of rhythms. Name them.
42. Left axis deviation is defined as an axis more negative than _____°.
43. Name three causes of sinus bradycardia.
44. Name three causes of atrial fibrillation.
45. Persistent ST segment elevations several weeks following an acute myocardial infarct suggest a possible _____.
46. Which of the following tachyarrhythmias is most likely to terminate abruptly following carotid sinus massage: sinus tachycardia, atrial fibrillation, AV nodal reentrant tachycardia, or ventricular tachycardia?
47. A wide biphasic P wave in lead V_1 may indicate _____.
48. Which of the following drugs may shorten the QT interval: digitalis, quinidine, procainamide, or furosemide (Lasix)?
49. Normally the QRS width is equal to or less than 0. _____ second.
50. A qR complex is normally seen in which lead: V_1 , V_6 , or aV_R ?

Define the Following Terms

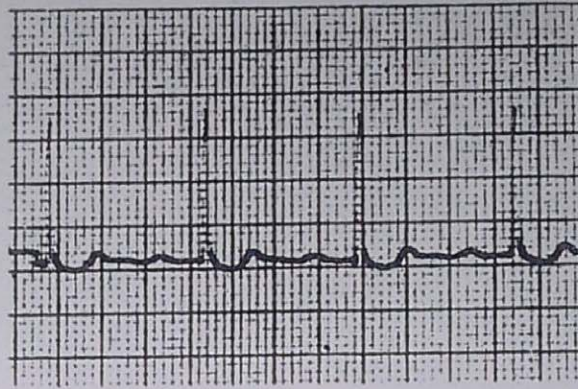
51. "R on T" phenomenon (p. 181)
52. Ectopic beat (p. 156)
53. Current of injury (p. 89)
54. Bypass tract (p. 137)
55. Escape beat (p. 151)
56. Bifascicular block (p. 197)
57. Frontal plane leads (p. 28)
58. Horizontal plane leads (p. 28)
59. Hyperacute T wave (p. 91)
60. Vertical QRS axis, horizontal QRS axis (p. 42)

Draw the QRS-T Pattern You Would Expect to See in Lead V₆ (for nos. 61 to 65)

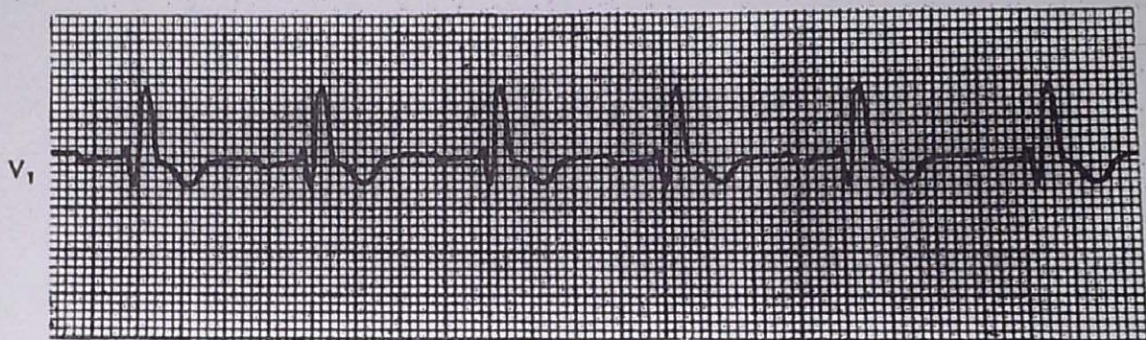
61. Normal pattern
62. Left bundle branch block
63. Right bundle branch block
64. Left ventricular hypertrophy with "strain"
65. Digitalis effect
66. What life-threatening metabolic abnormality caused the ECG findings in this patient?



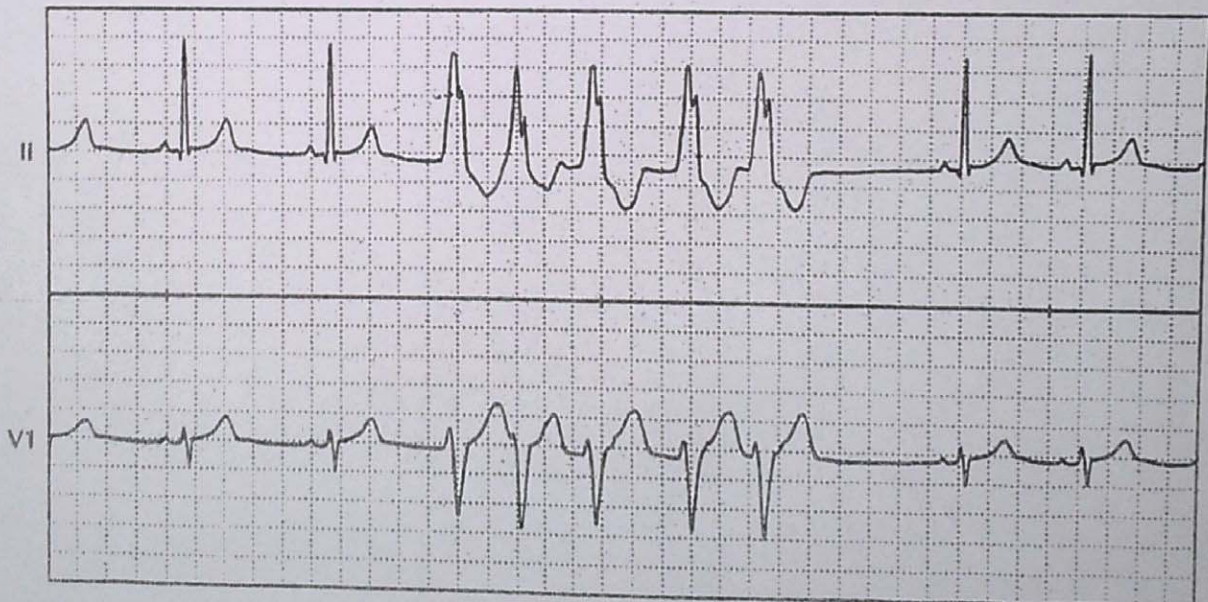
67. What drug could have produced these ST-T changes?



68. What ventricular conduction disturbance is present here?



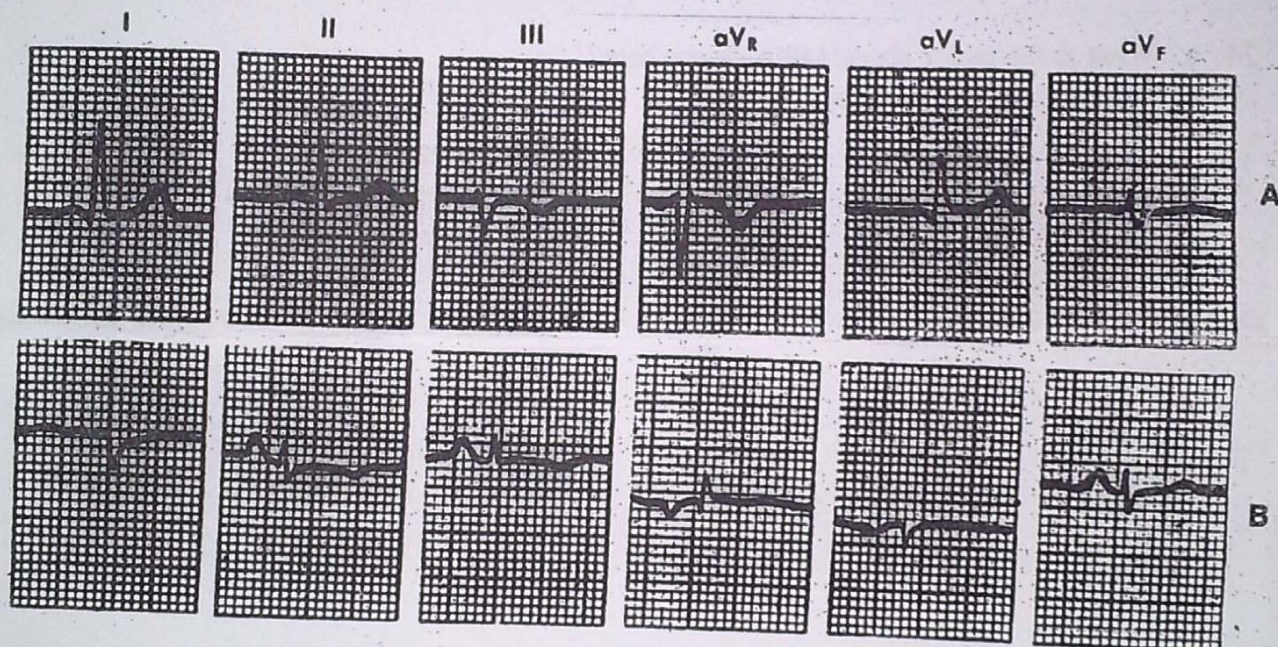
69. What is this abnormal heart rhythm?



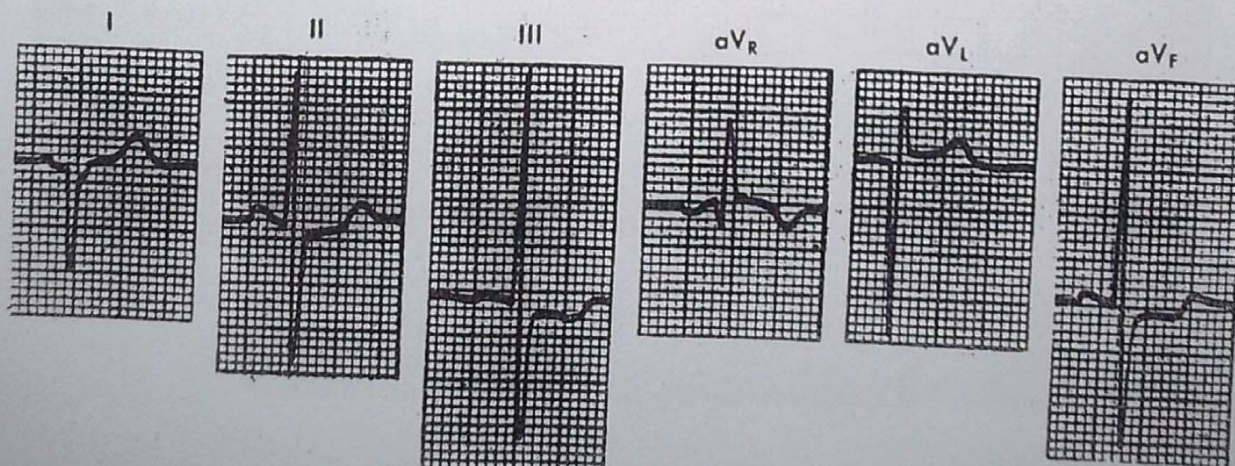
70. What is X?



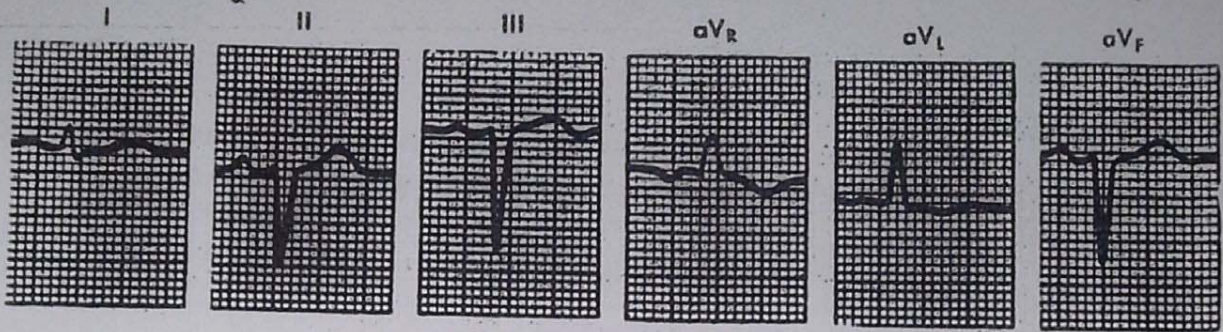
71. Calculate the approximate mean QRS axis in A and B.



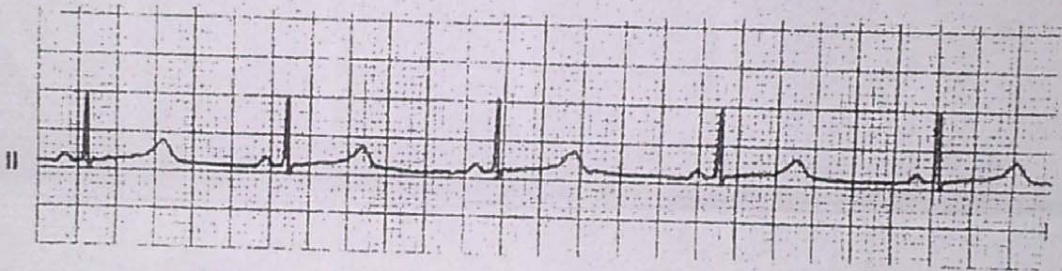
72. Calculate the approximate mean QRS axis in these leads.



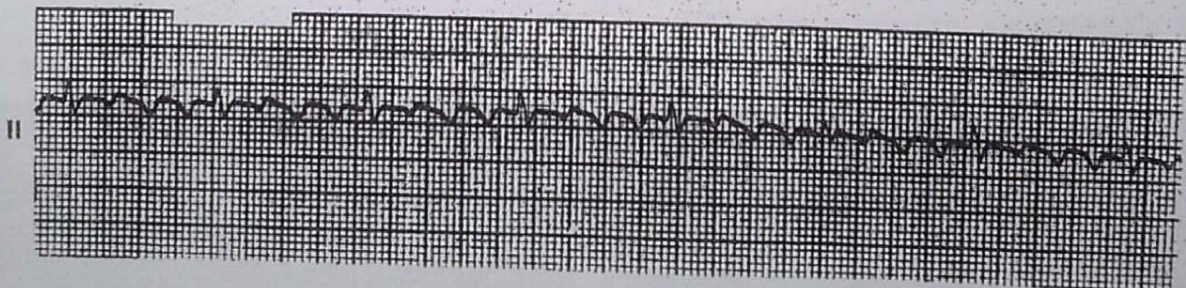
73. Is the mean QRS axis in this example normal, right, or left?



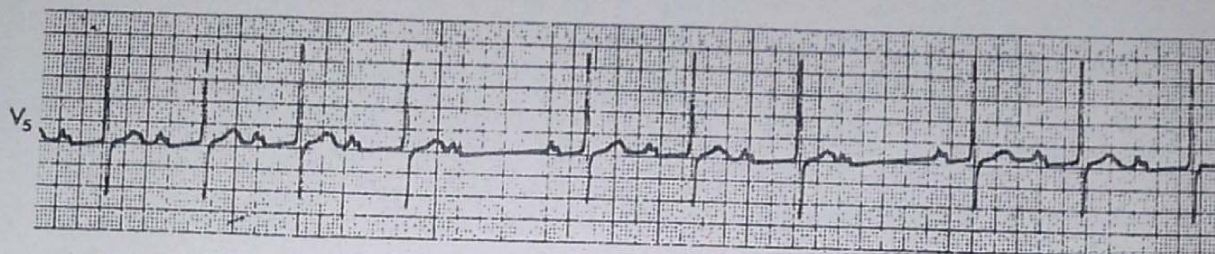
74. a. What is the major abnormality shown here?
b. What factors can produce it?



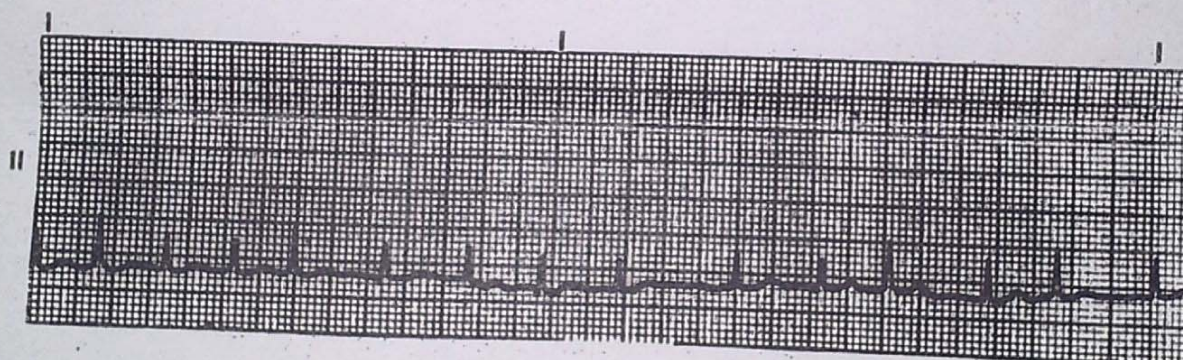
75. What is the heart rhythm?



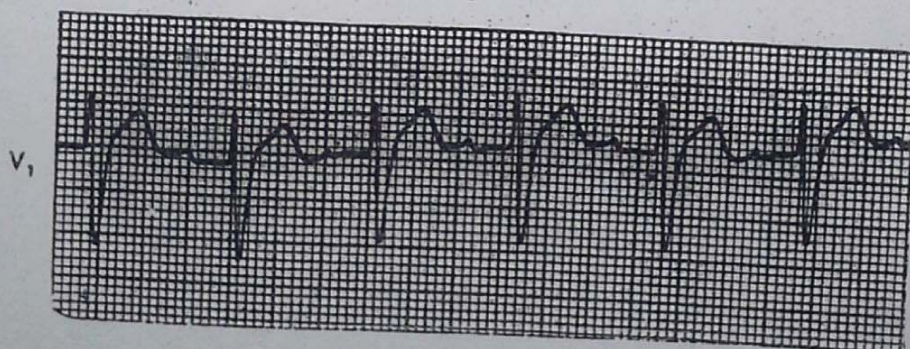
76. a. What is the approximate sinus (P wave) rate?
 b. What type of AV conduction disturbance is present?
 c. What abnormality is indicated by the P waves?



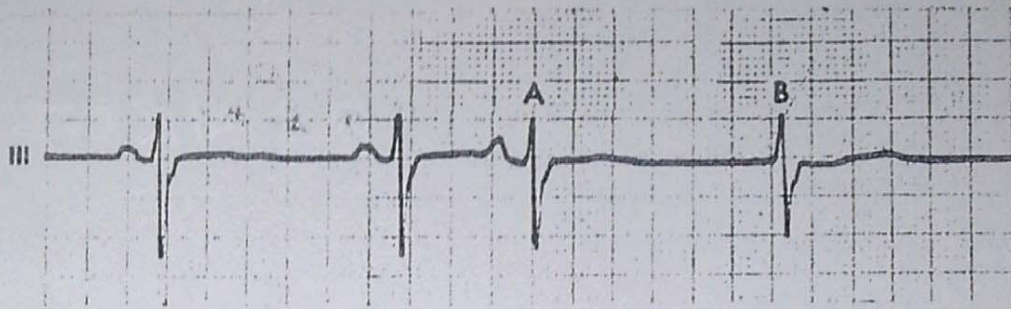
77. a. What is the approximate heart rate?
 b. What arrhythmia is present here?



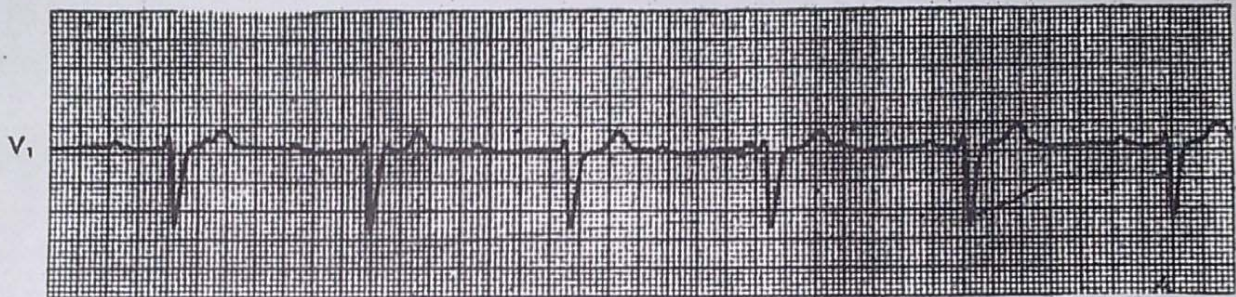
78. What type of AV conduction disturbance is present?



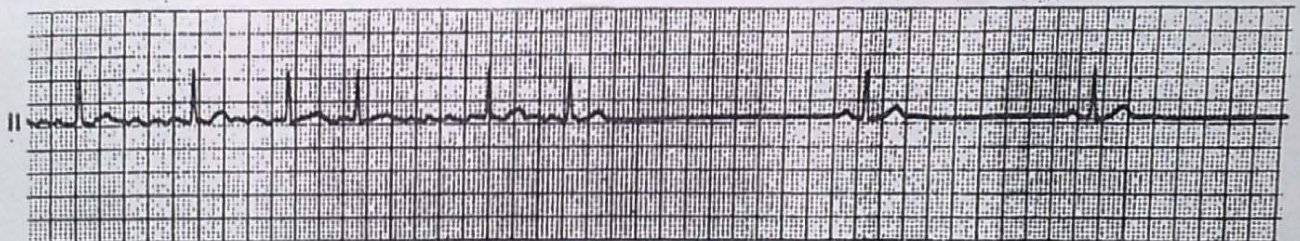
79. Identify beats A and B.



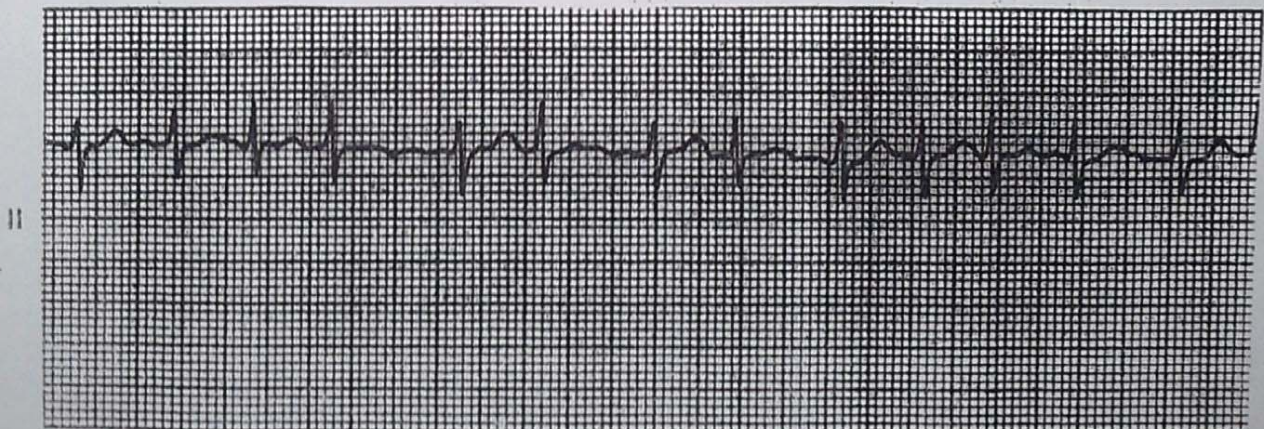
80. a. What arrhythmia is present?
b. Of what symptom might this patient be complaining?



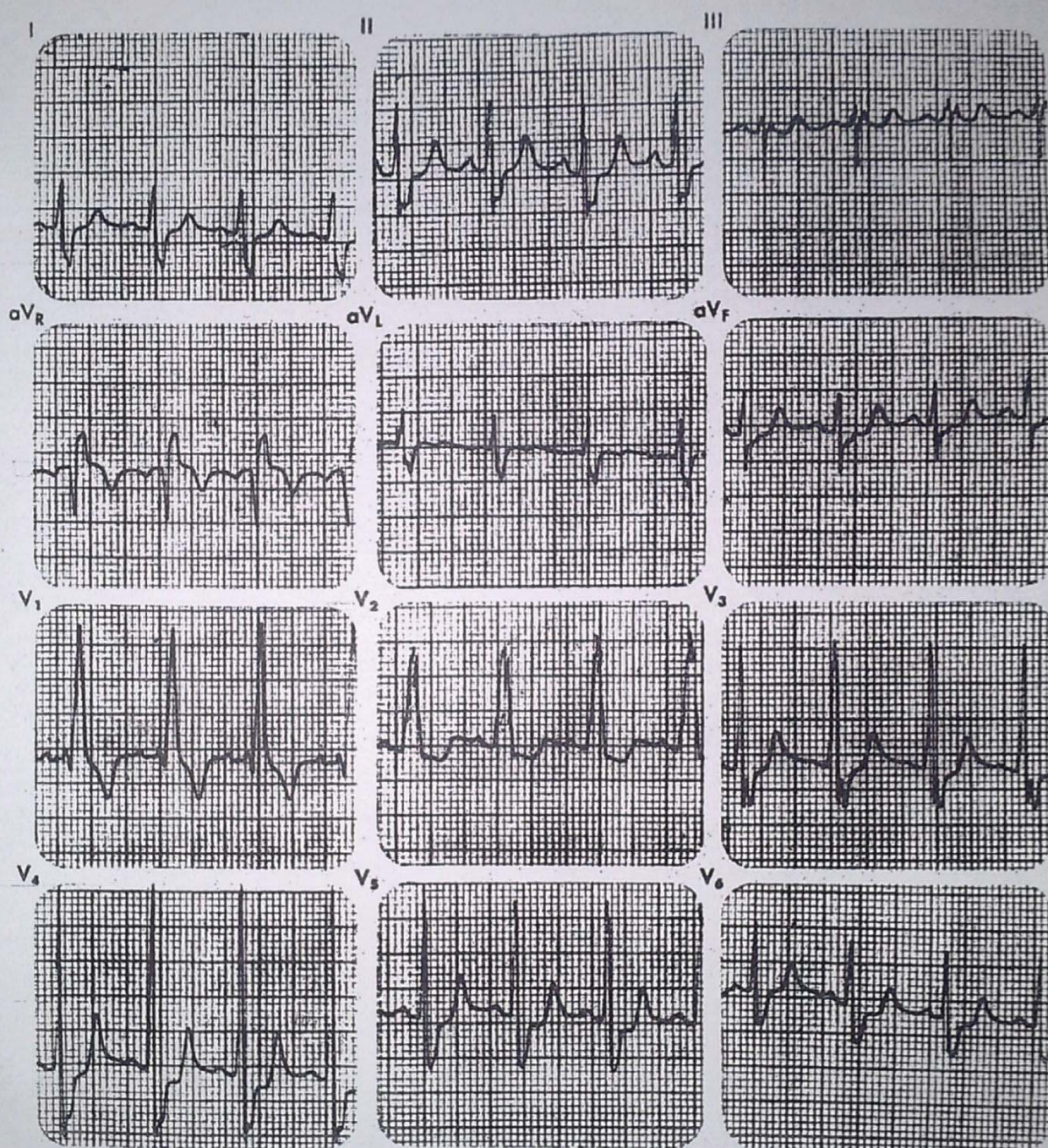
81. Look at the first and second halves of this rhythm strip. What are the rhythms? What syndrome do they suggest?



82. What is the arrhythmia shown here? Name three conditions that might lead to it.

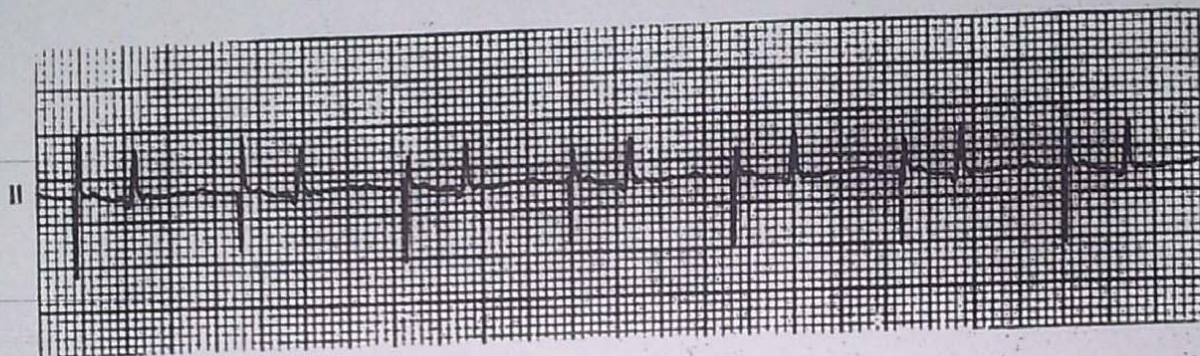


83. What type of ventricular conduction disturbance is present here?

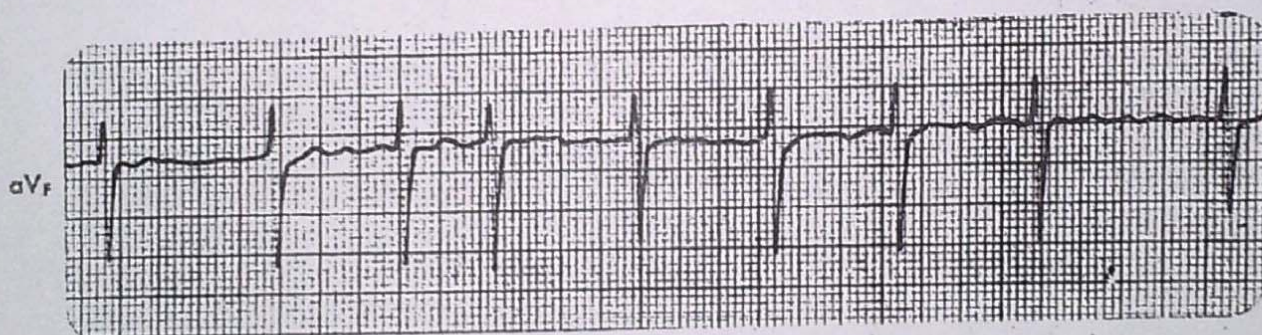


Identify the Rhythm in Each Case
(for nos. 84 to 111)

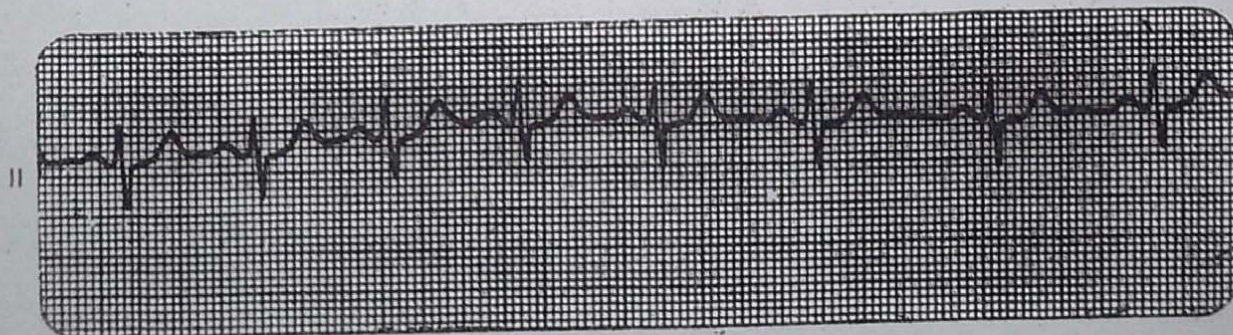
84.



85.



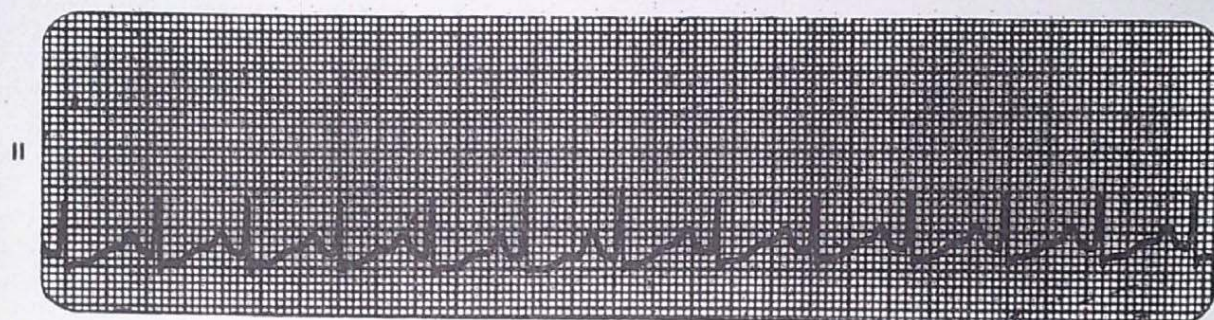
86.



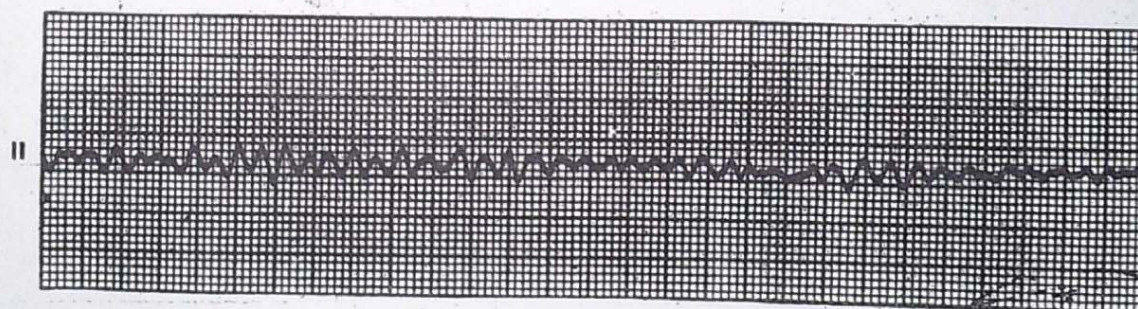
87.



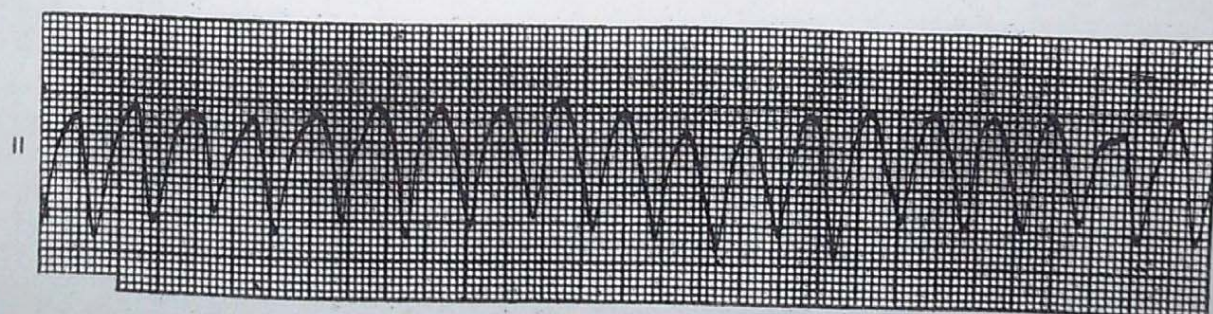
88.



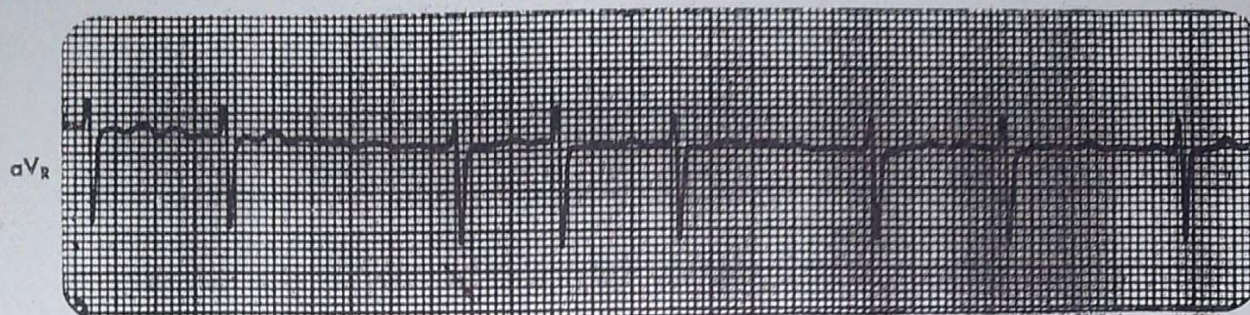
89.



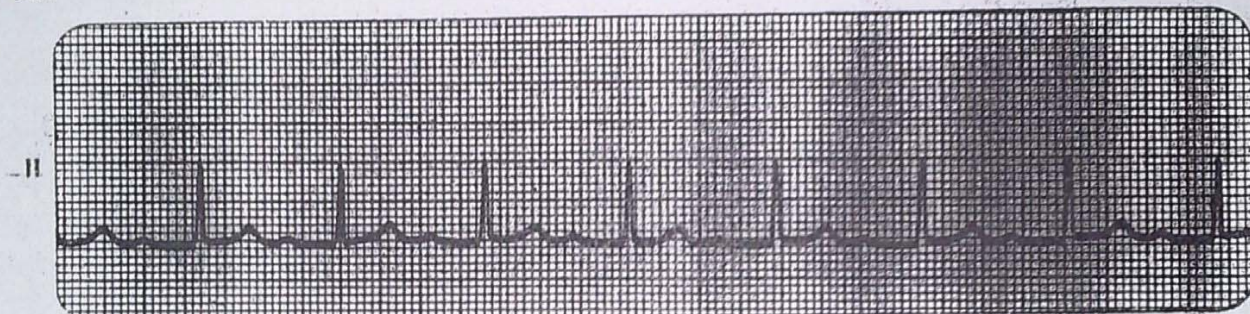
90.



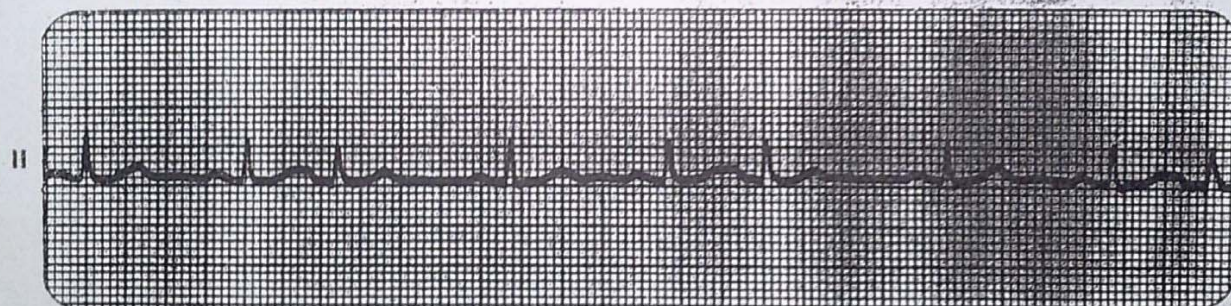
91.



92.

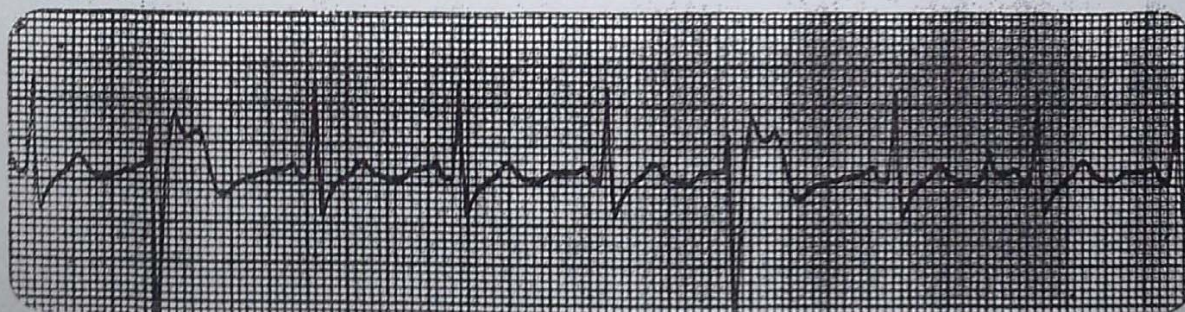


93.

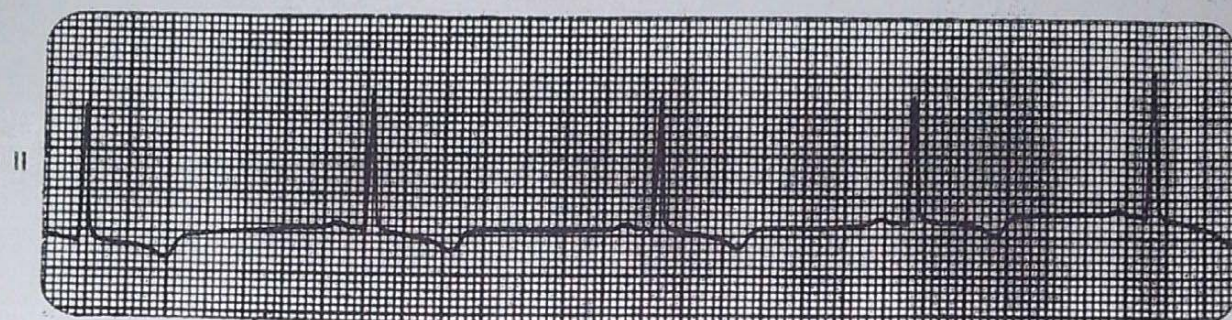


94.

Monitor lead



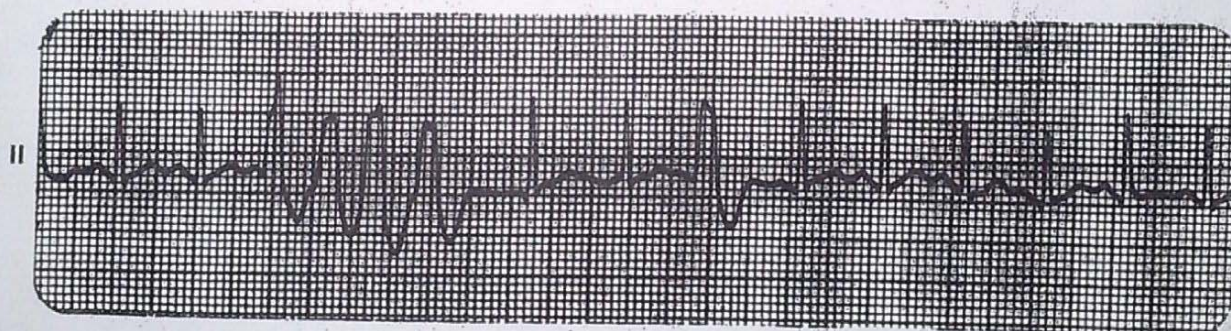
95.



96.

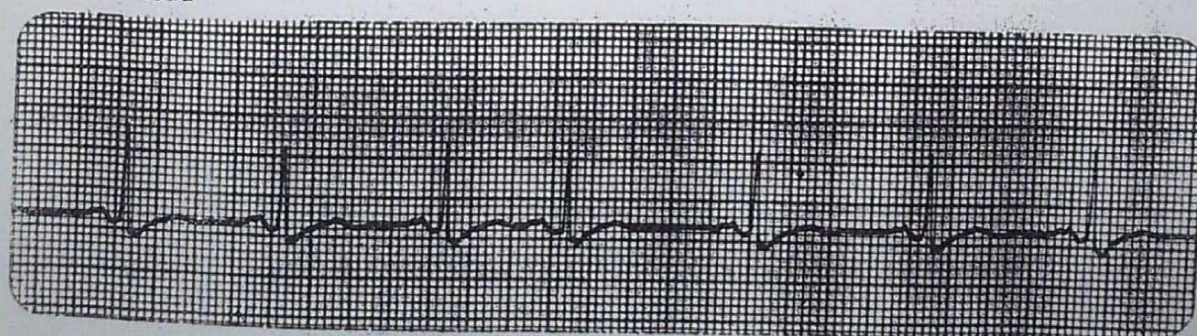


97.

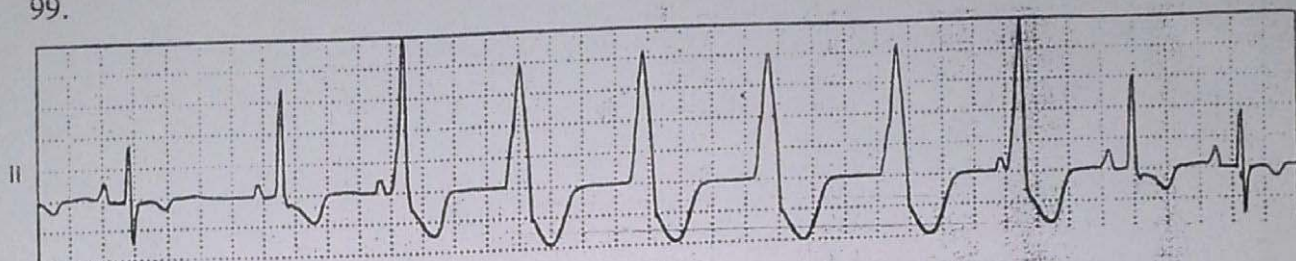


98.

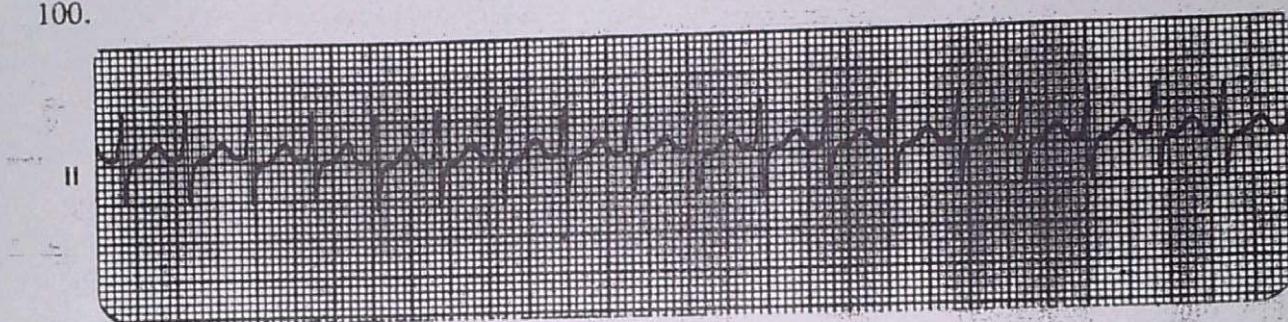
Monitor lead



99.

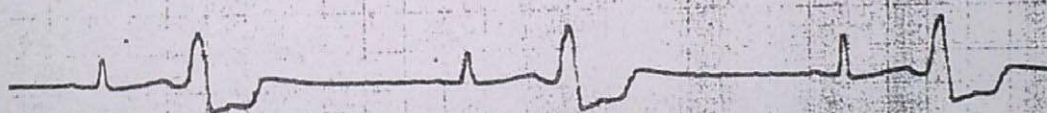


100.

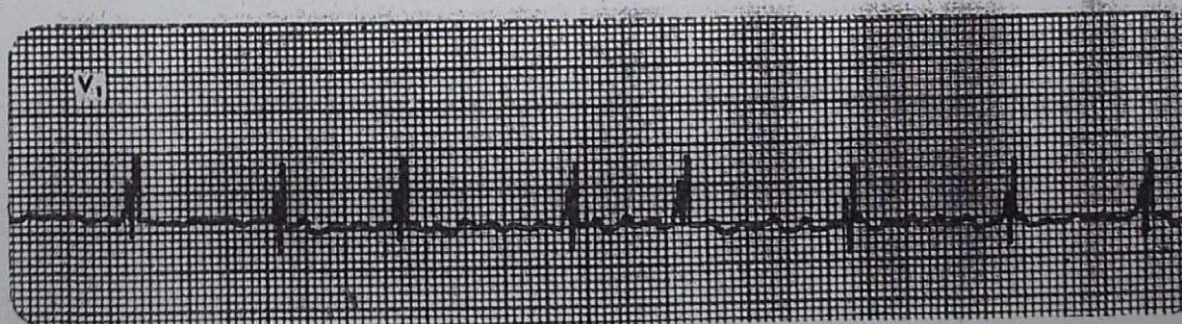


101.

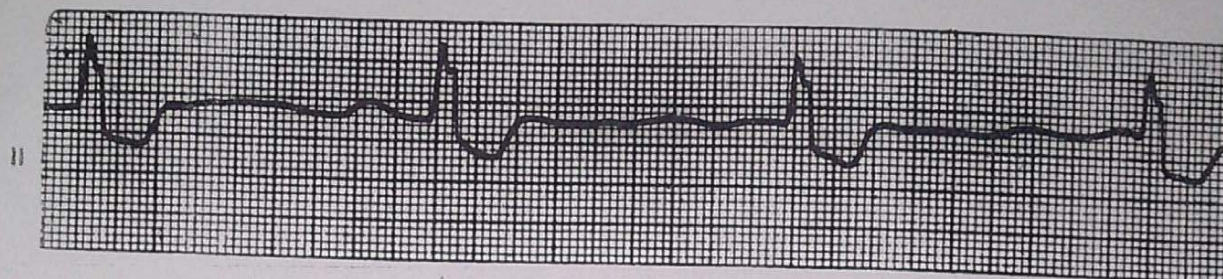
Monitor lead



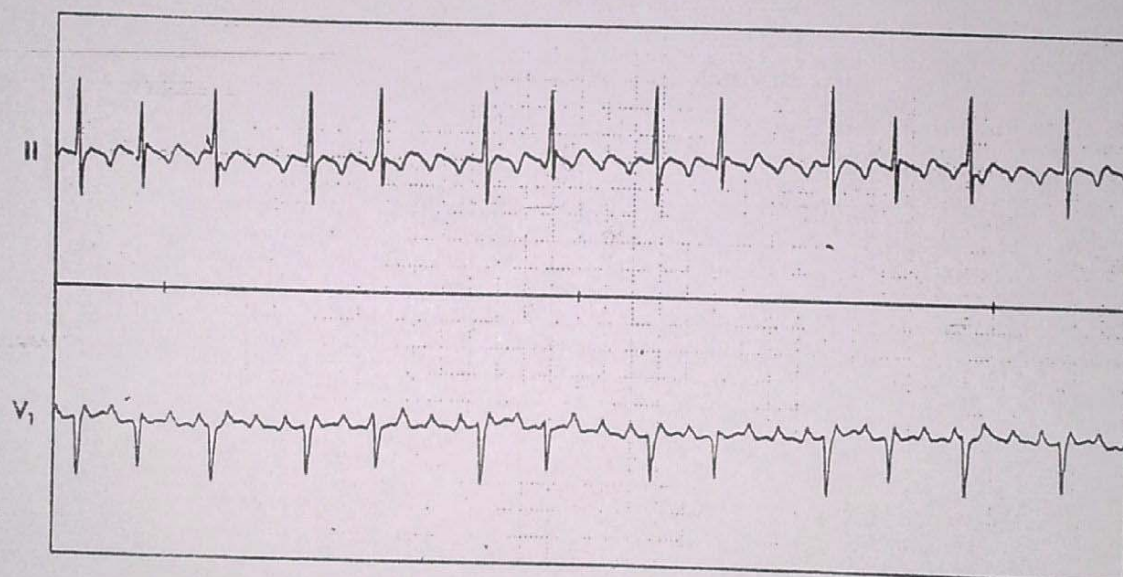
102.



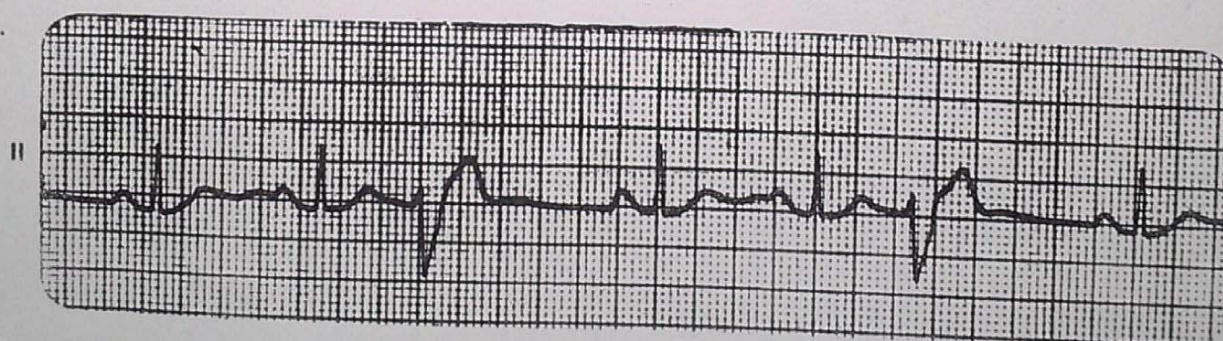
103.



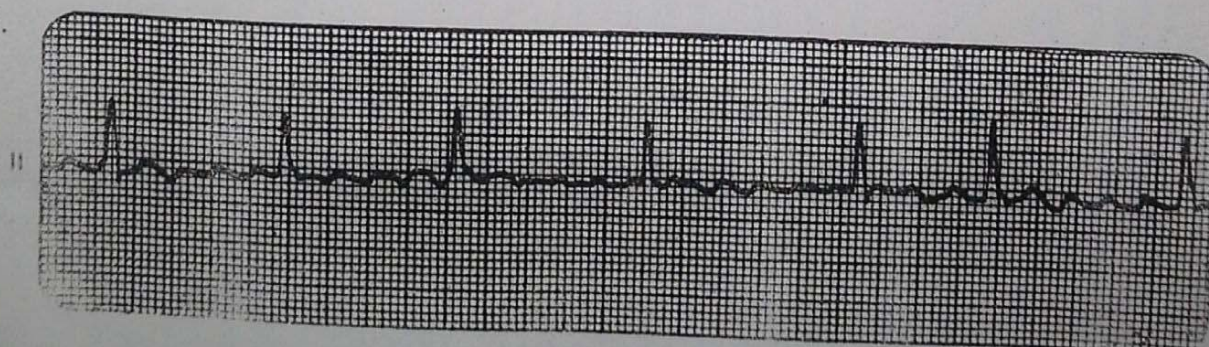
104.



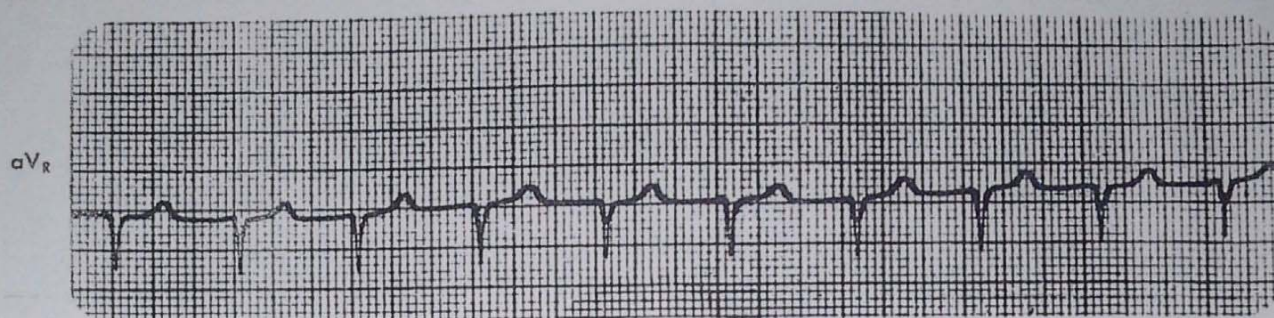
105.



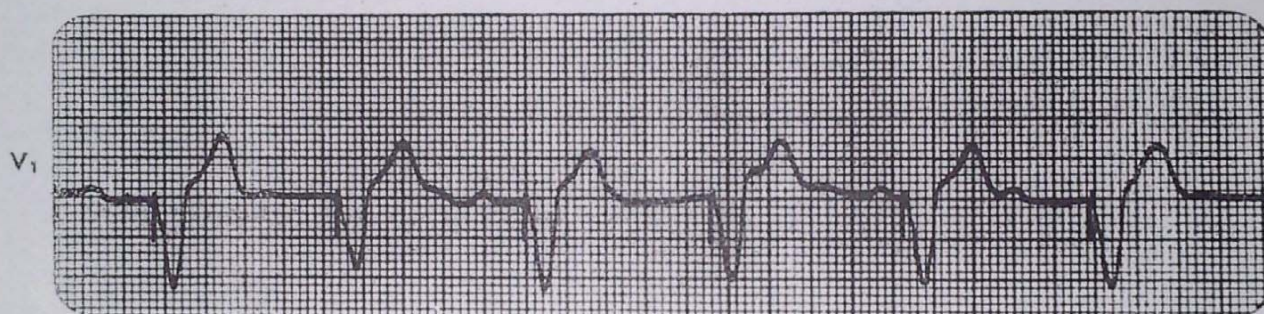
106.



107.

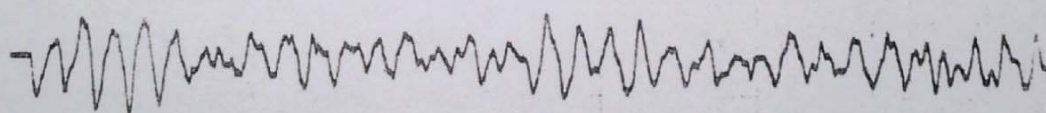


108.



109.

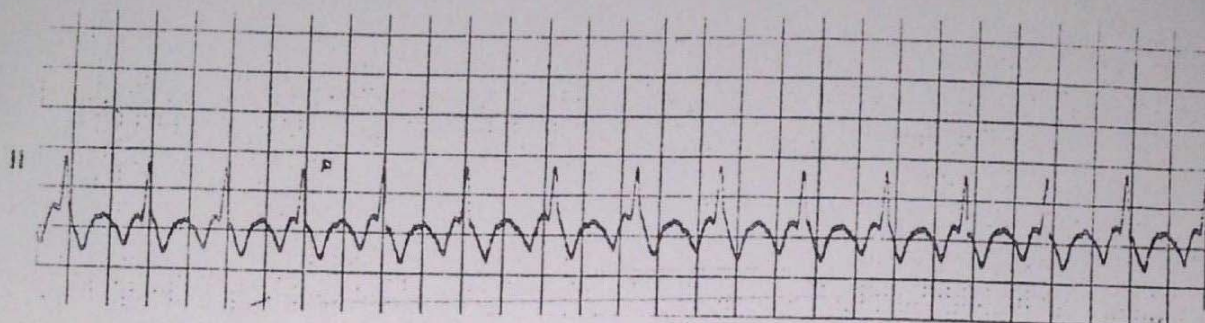
MONITOR LEAD



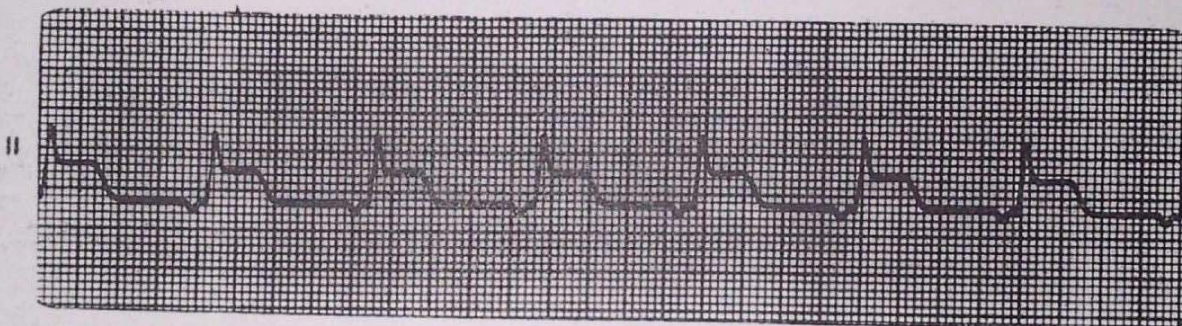
110.



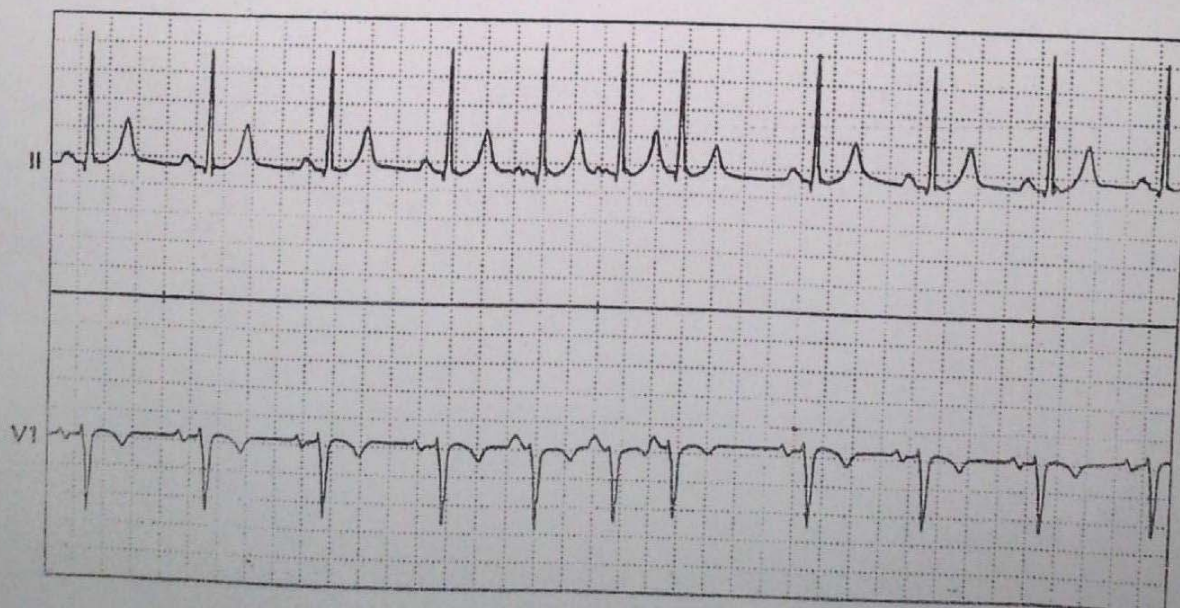
111.



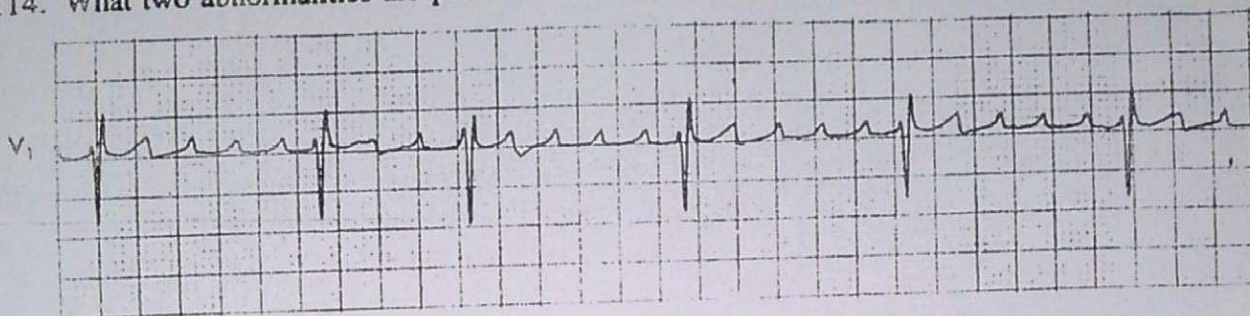
112. What two abnormalities are present here?



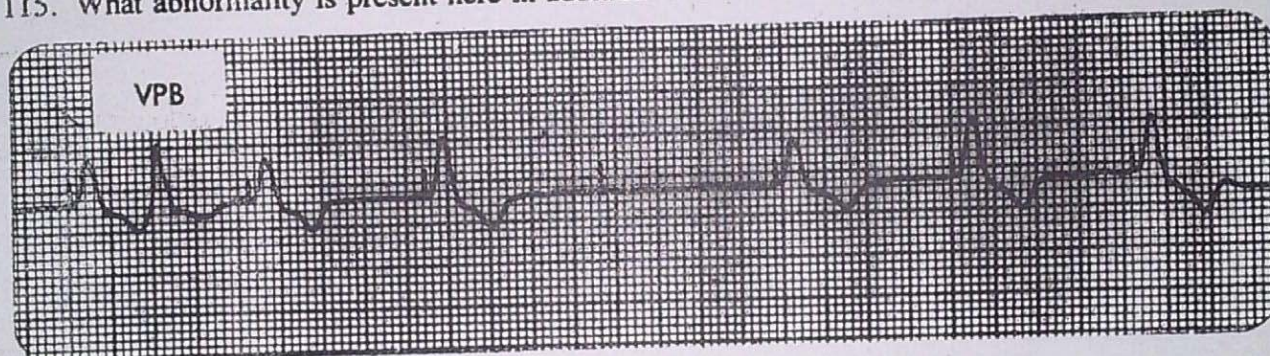
113. A 50-year-old patient complained of palpitations during the time this Holter monitor record was being obtained. What arrhythmia is shown?



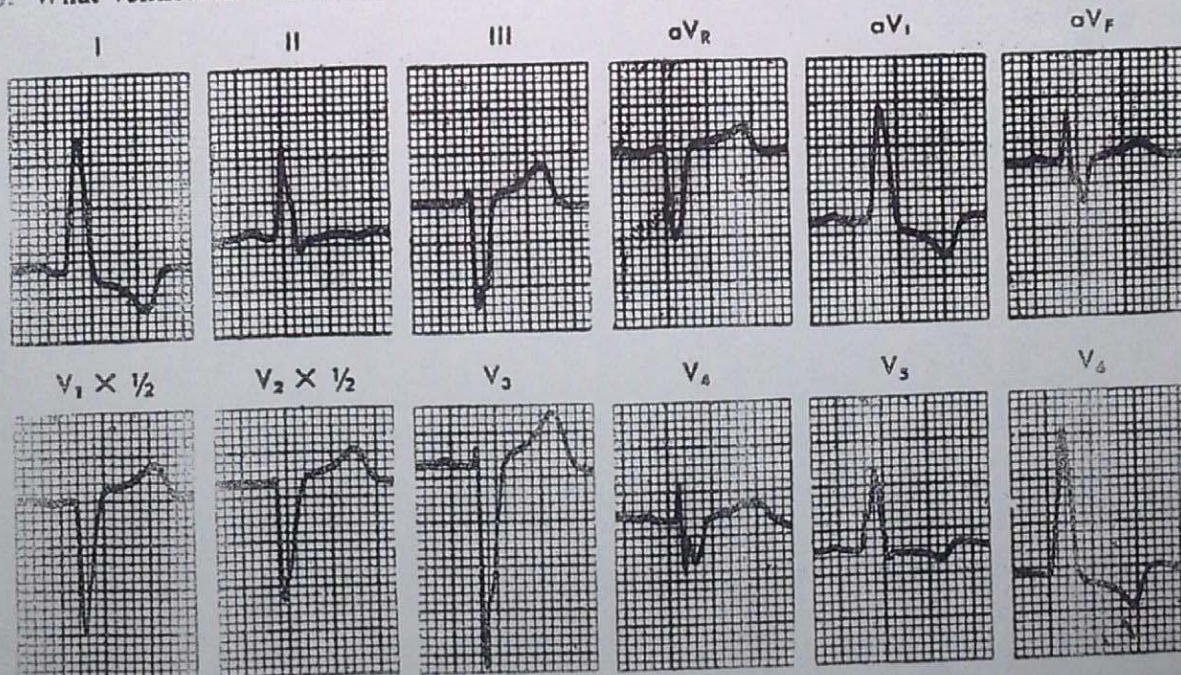
114. What two abnormalities are present?



115. What abnormality is present here in addition to the VPB?



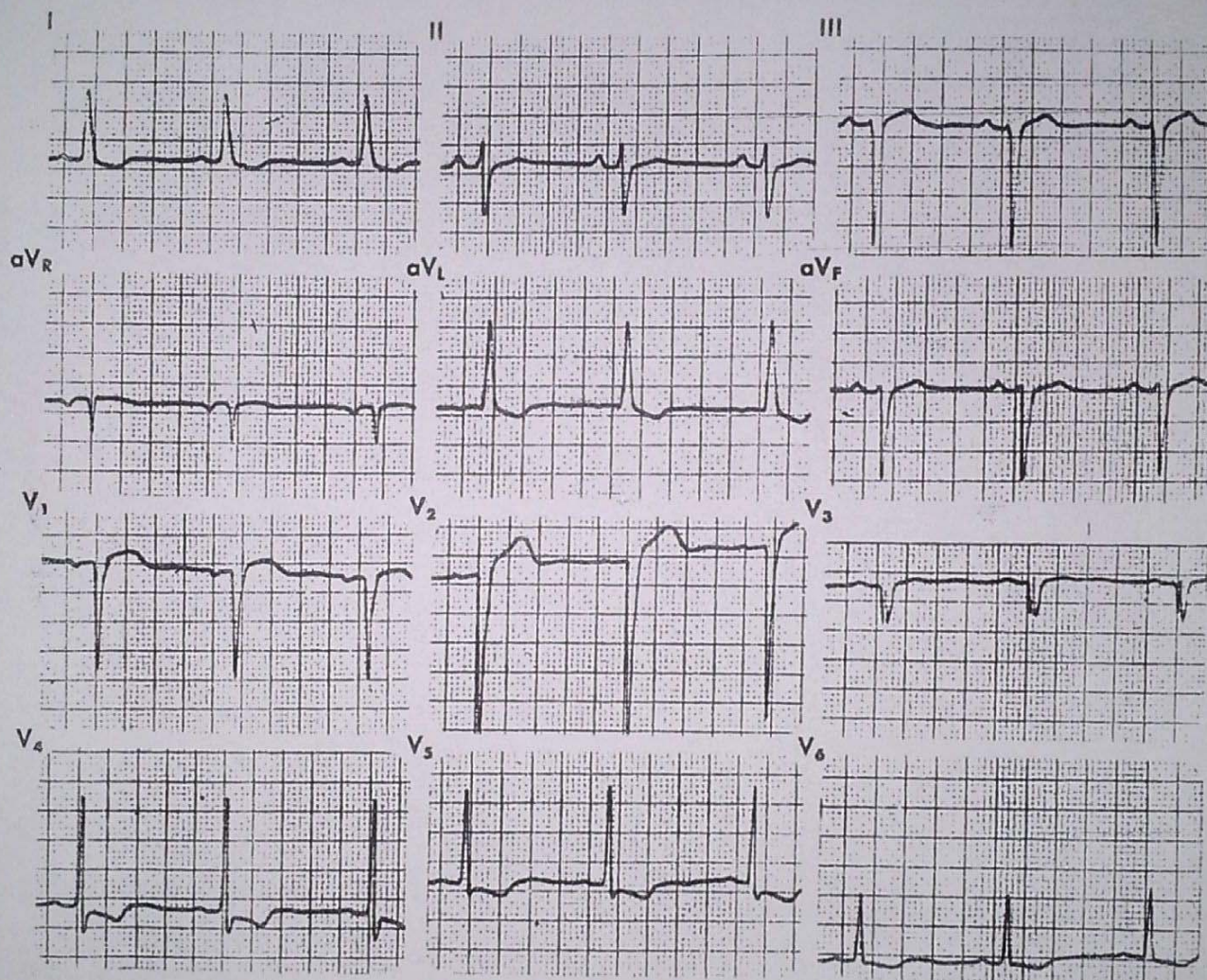
116. What ventricular conduction disturbance is present?



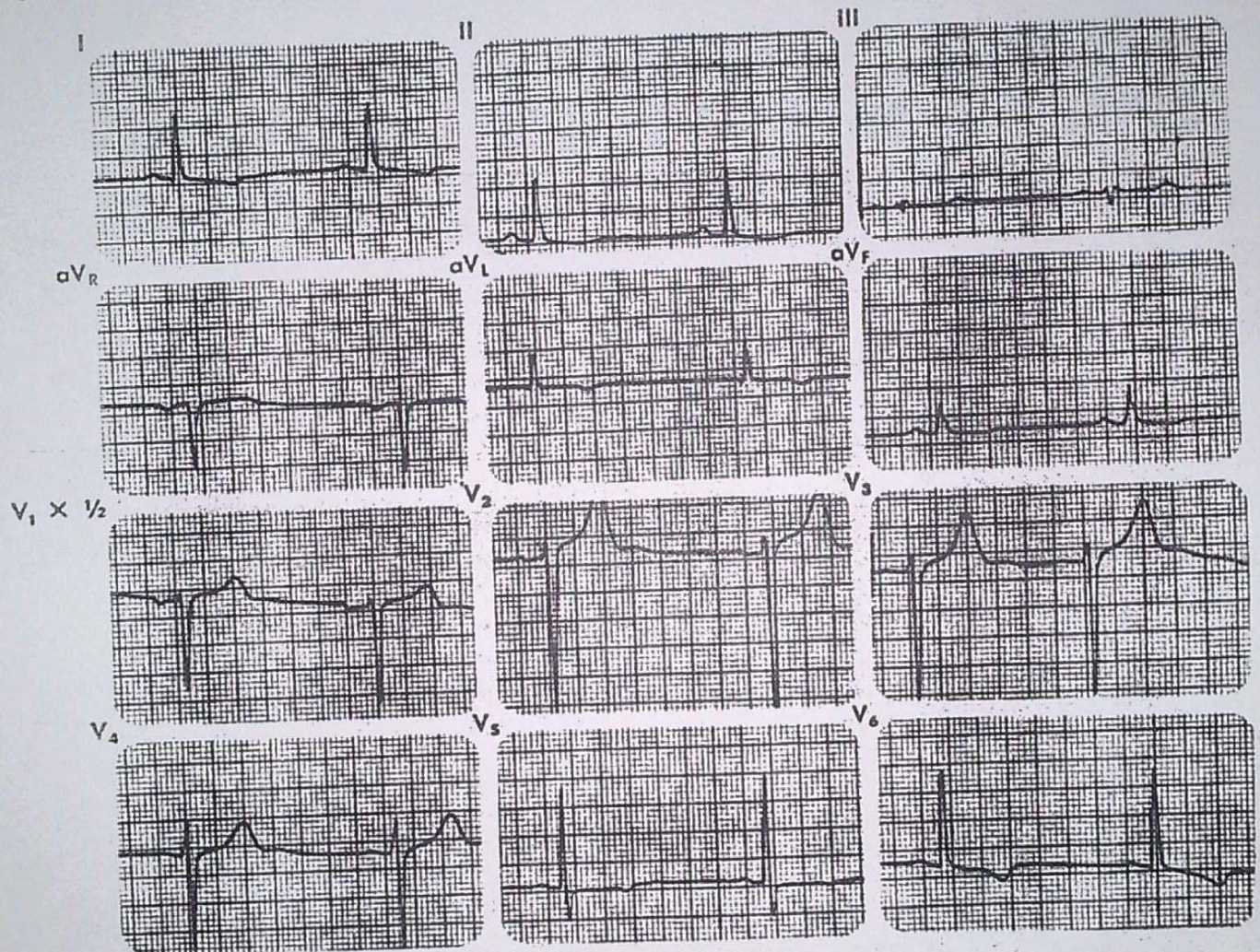
Interpret These ECGs Fully According to the Method Suggested in Chapter 21

(for nos. 117 to 121)

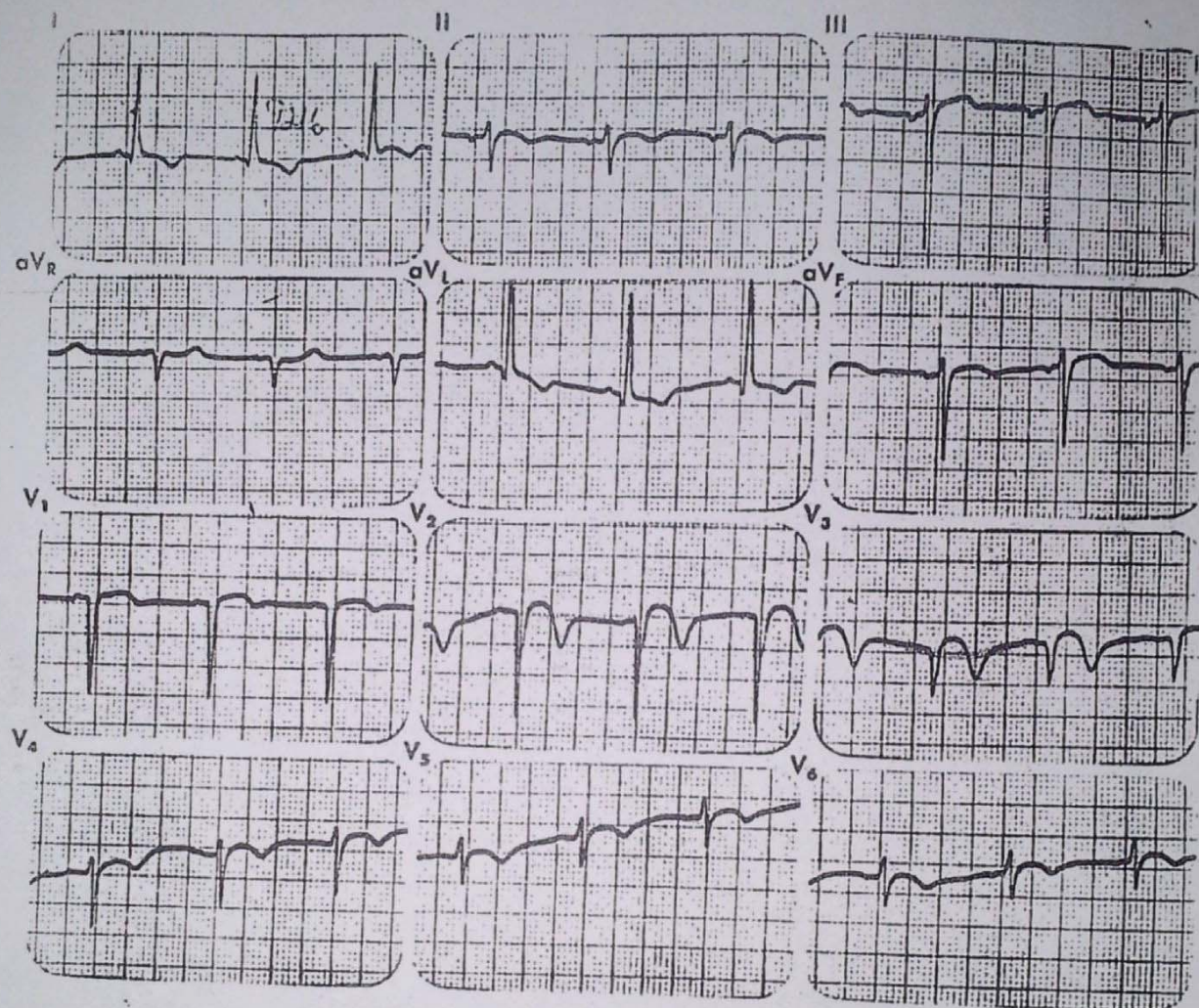
117.



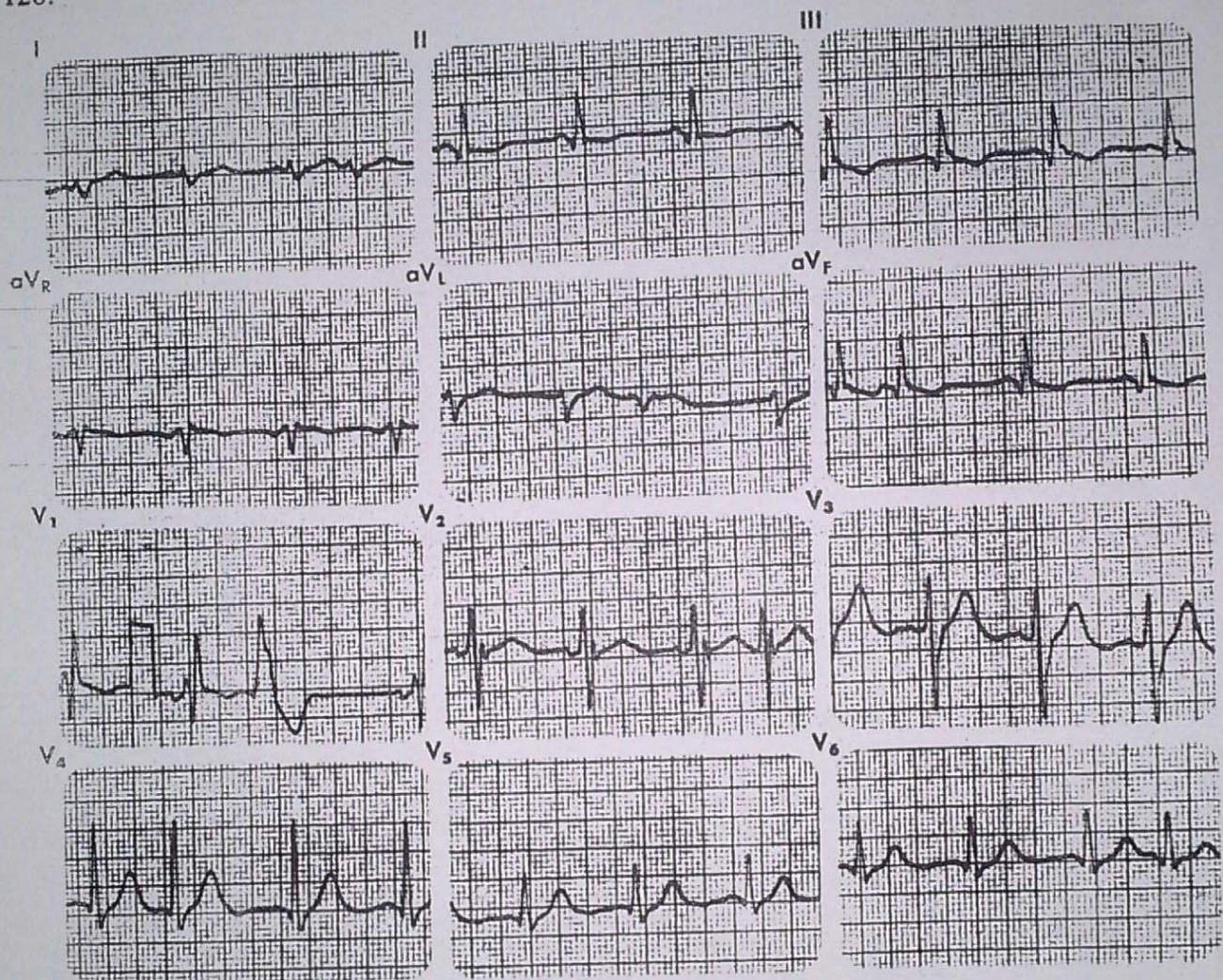
118.



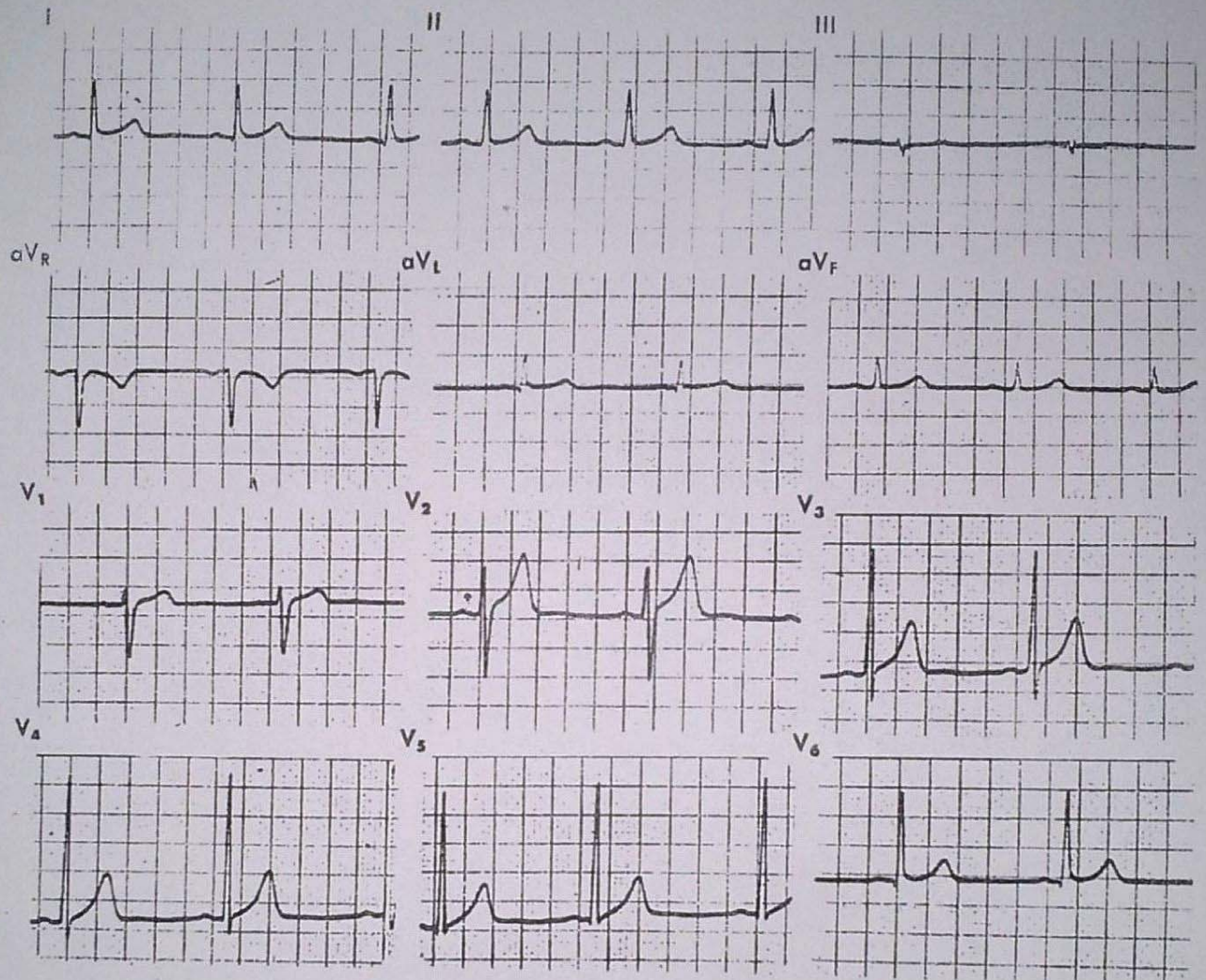
119.



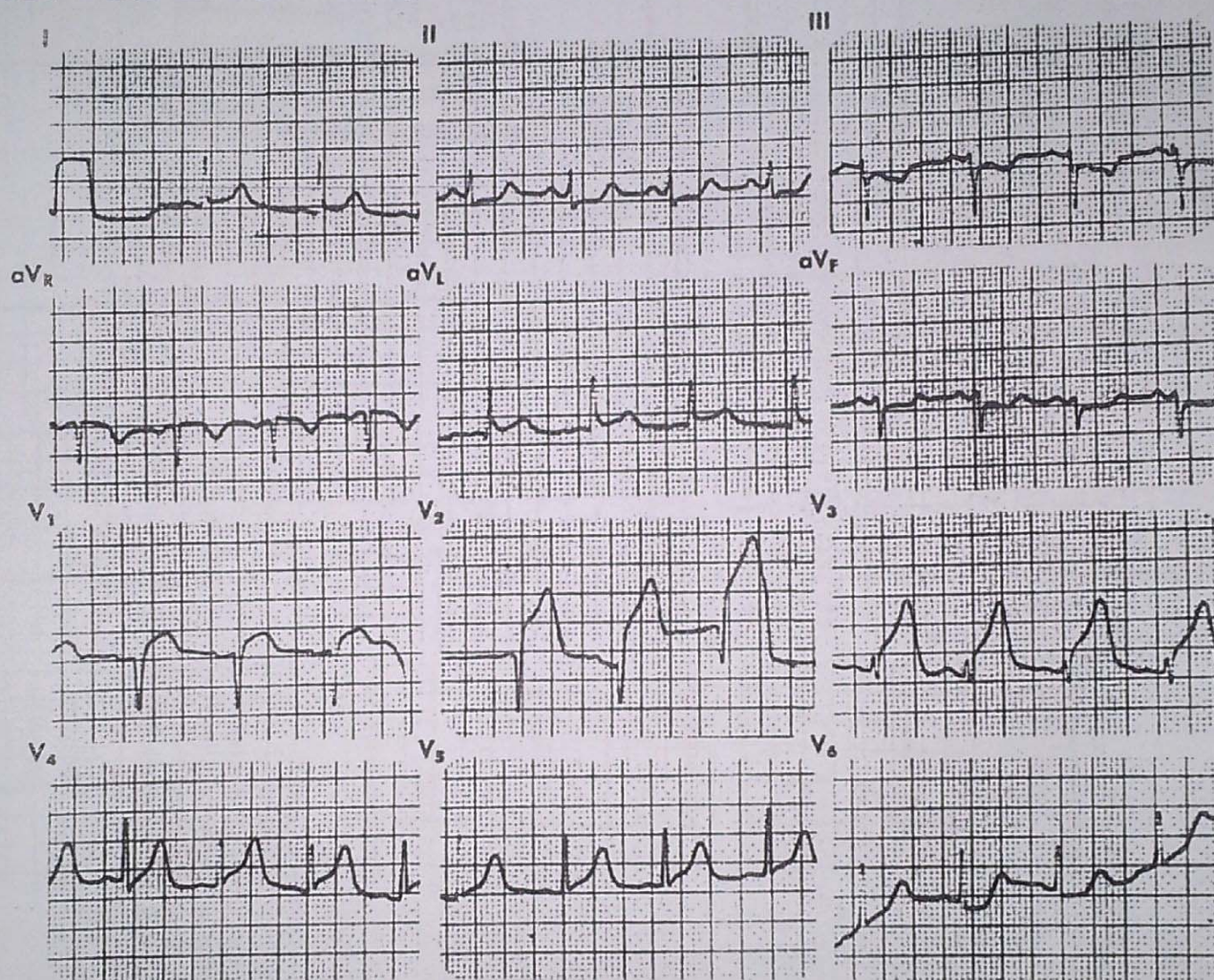
120.



121.

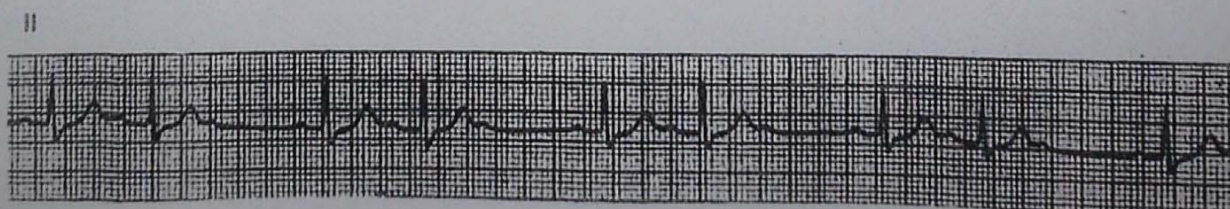


122. What is the major ECG diagnosis here?



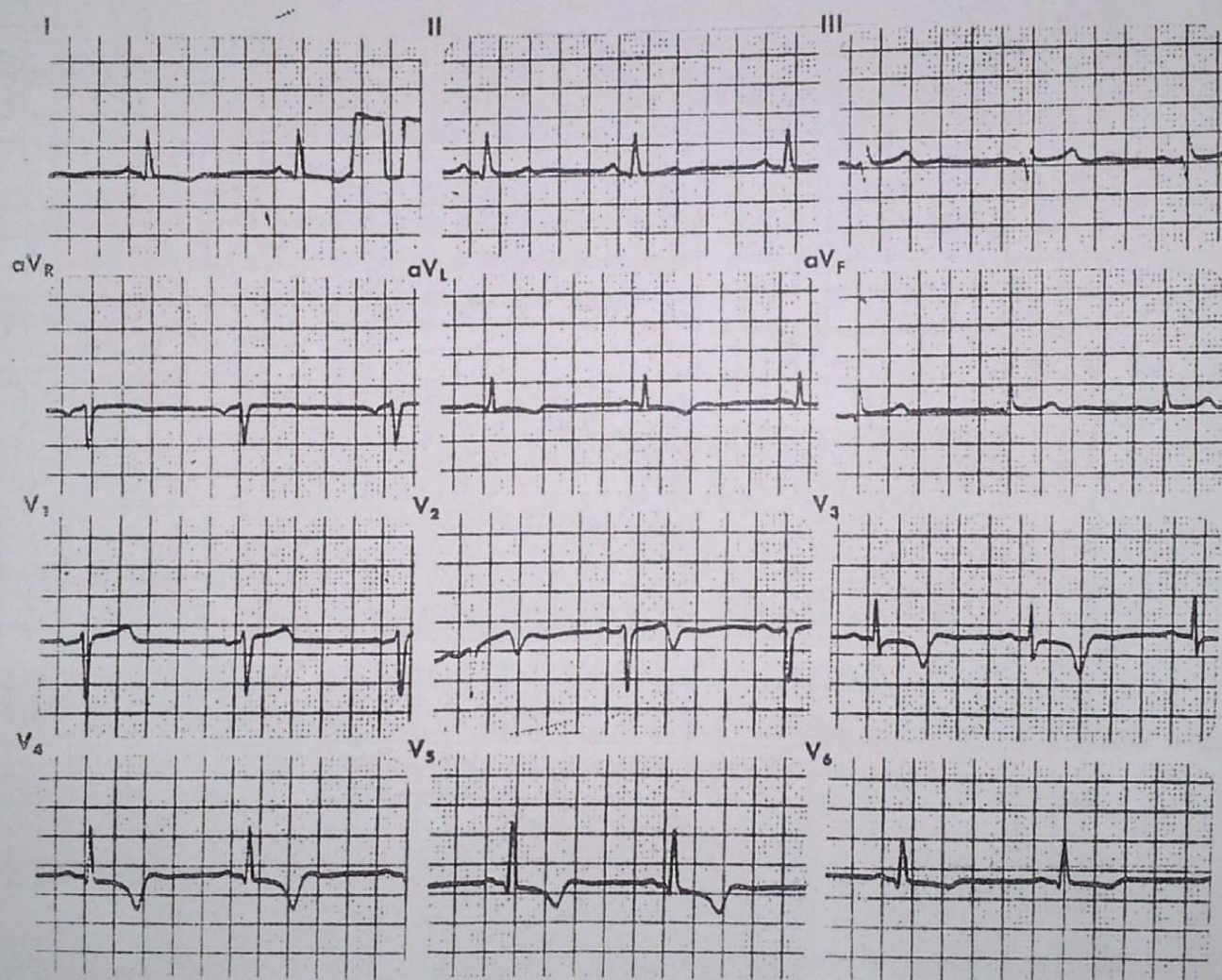
123. The following rhythm strip shows

- Sinus rhythm with frequent premature atrial beats
- Sinus rhythm with complete heart block
- Sinus rhythm with 3:2 AV Wenckebach
- Multifocal atrial tachycardia
- Sinus arrhythmia



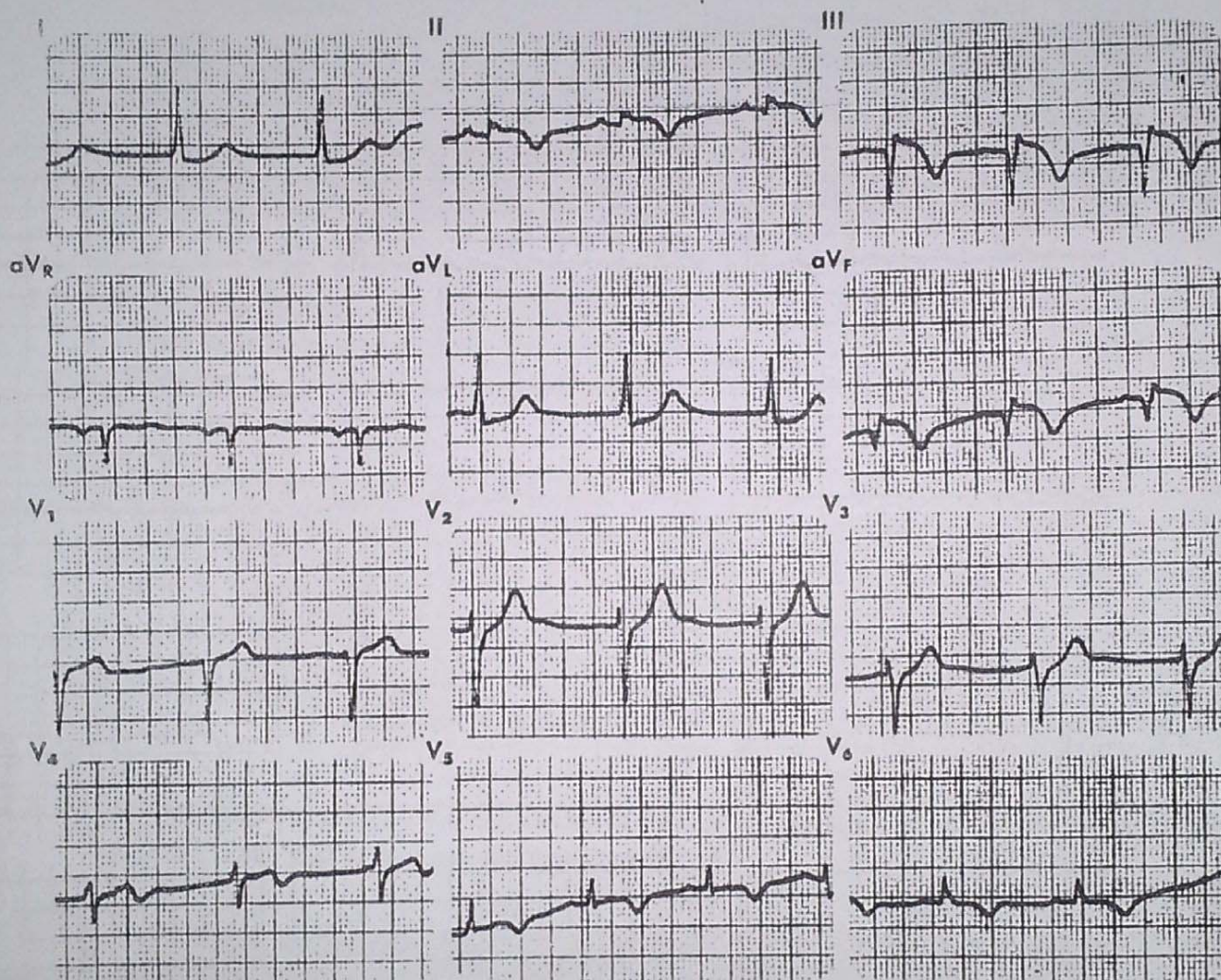
124. Answer these questions about the following ECG:

- Is it properly standardized?
- What is the heart rate?
- Is sinus rhythm present?
- What is the mean QRS axis?
- Is axis deviation present?
- Is the QRS voltage normal?
- What is the major abnormality?



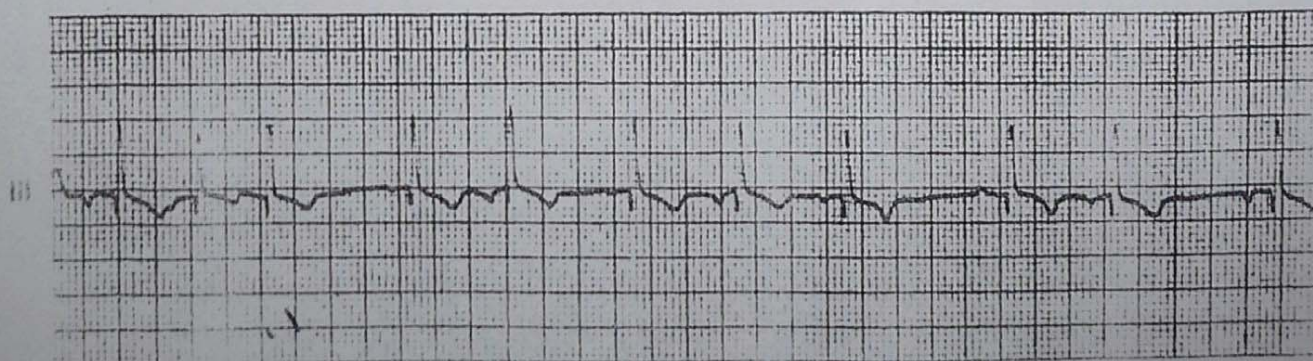
125. Answer these questions about the following ECG:

- What is the approximate heart rate?
- What evidence is there of myocardial infarction?

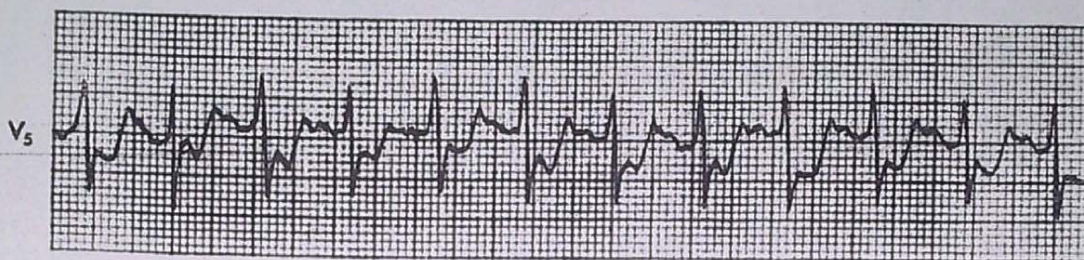


126. The following rhythm strip shows

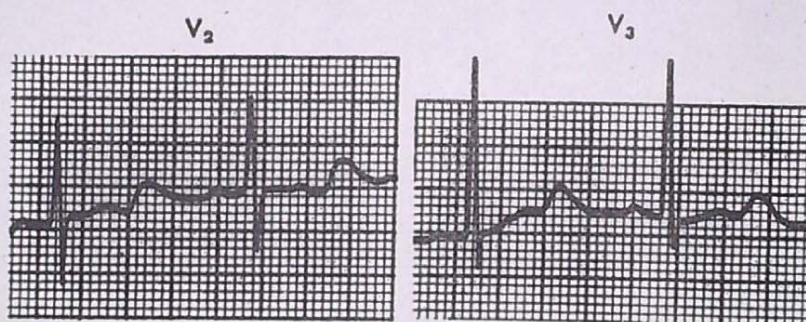
- Atrial fibrillation
- Paroxysmal atrial tachycardia
- Multifocal atrial tachycardia
- Atrial bigeminy



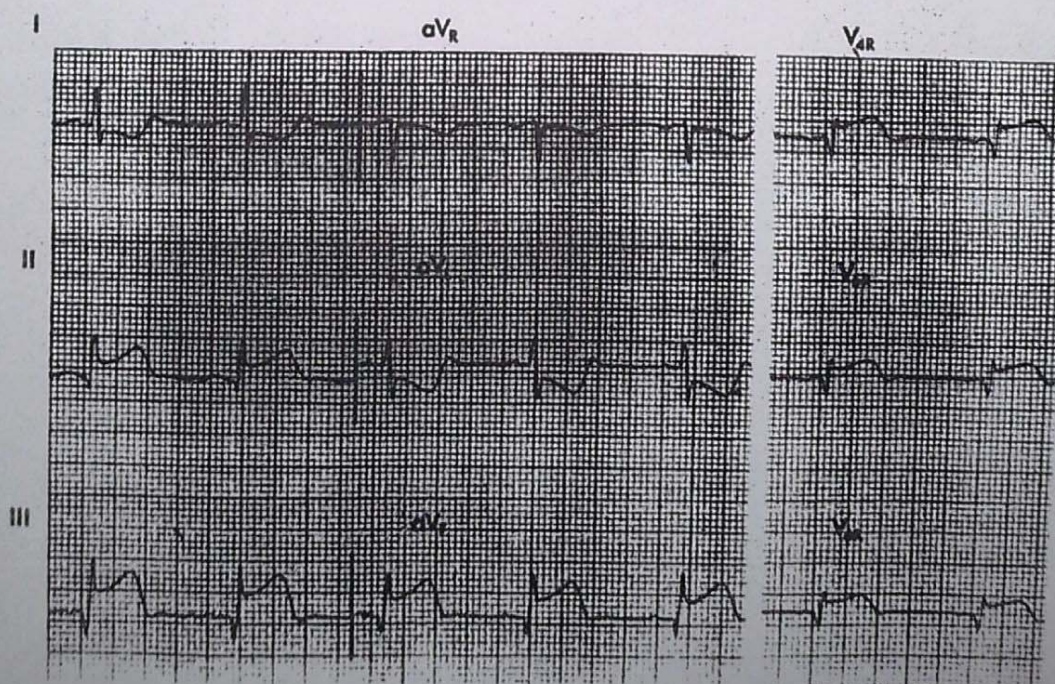
127. The ECG strip below, obtained during an exercise test, shows
- Ventricular tachycardia
 - ST changes consistent with acute transmural infarction
 - ST changes consistent with Prinzmetal's angina
 - ST changes consistent with acute subendocardial ischemia



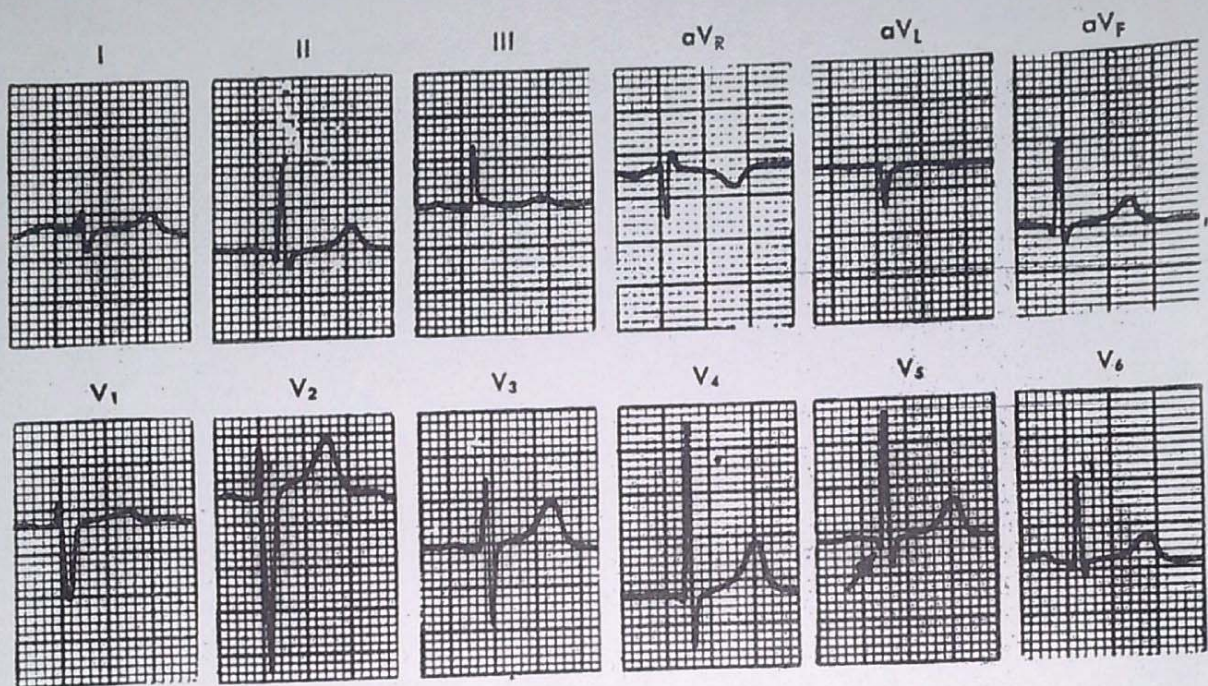
128. Answer these questions from the following ECG:
- What waveform is abnormally prominent here?
 - What are the major causes for this finding?



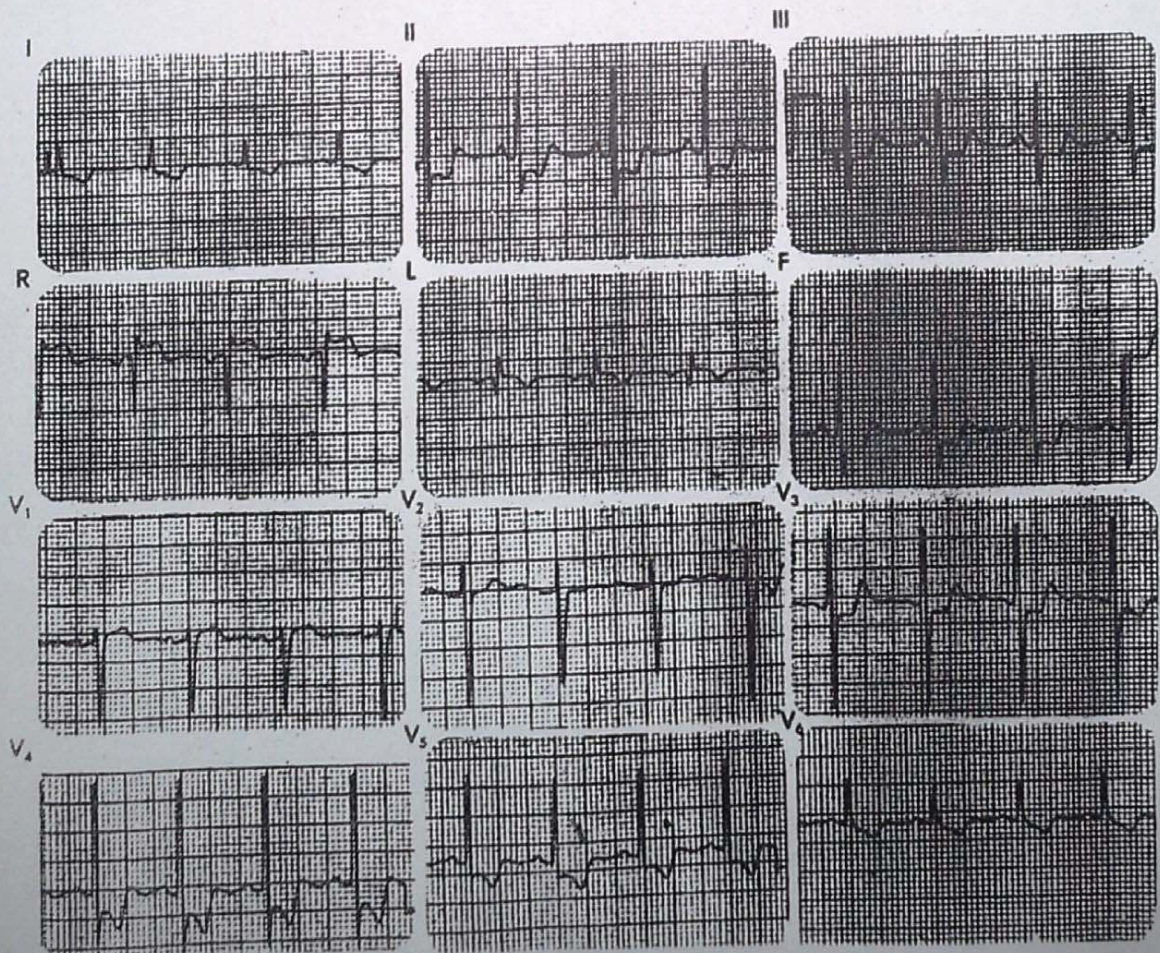
129. A 46-year-old man presented complaining of having had 4 hours of chest pain. What is the diagnosis? Note: V_{4R} to V_{6R} are right precordial leads.



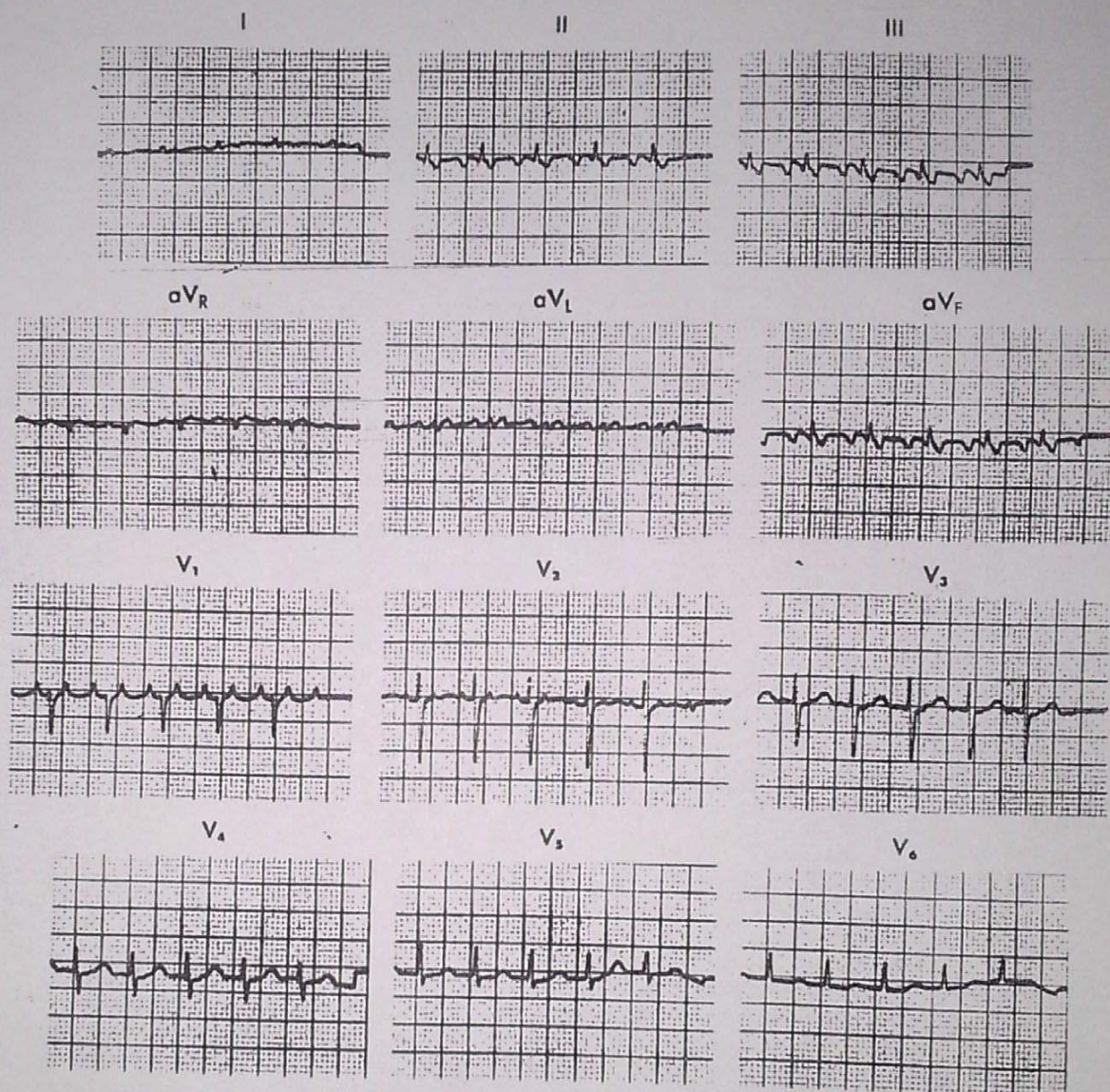
130. What wave does the arrow in V_5 point to, and what is the significance of this wave?



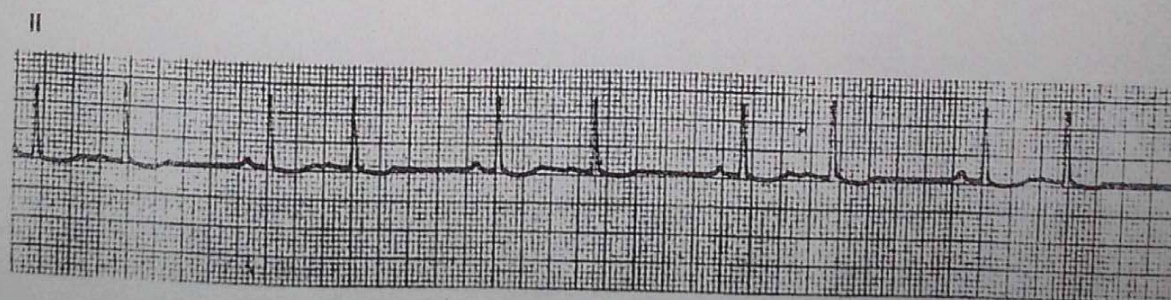
131. A patient complaining of severe chest pain had abnormally elevated cardiac enzymes. Using the ECG shown below, what is the clinical diagnosis?



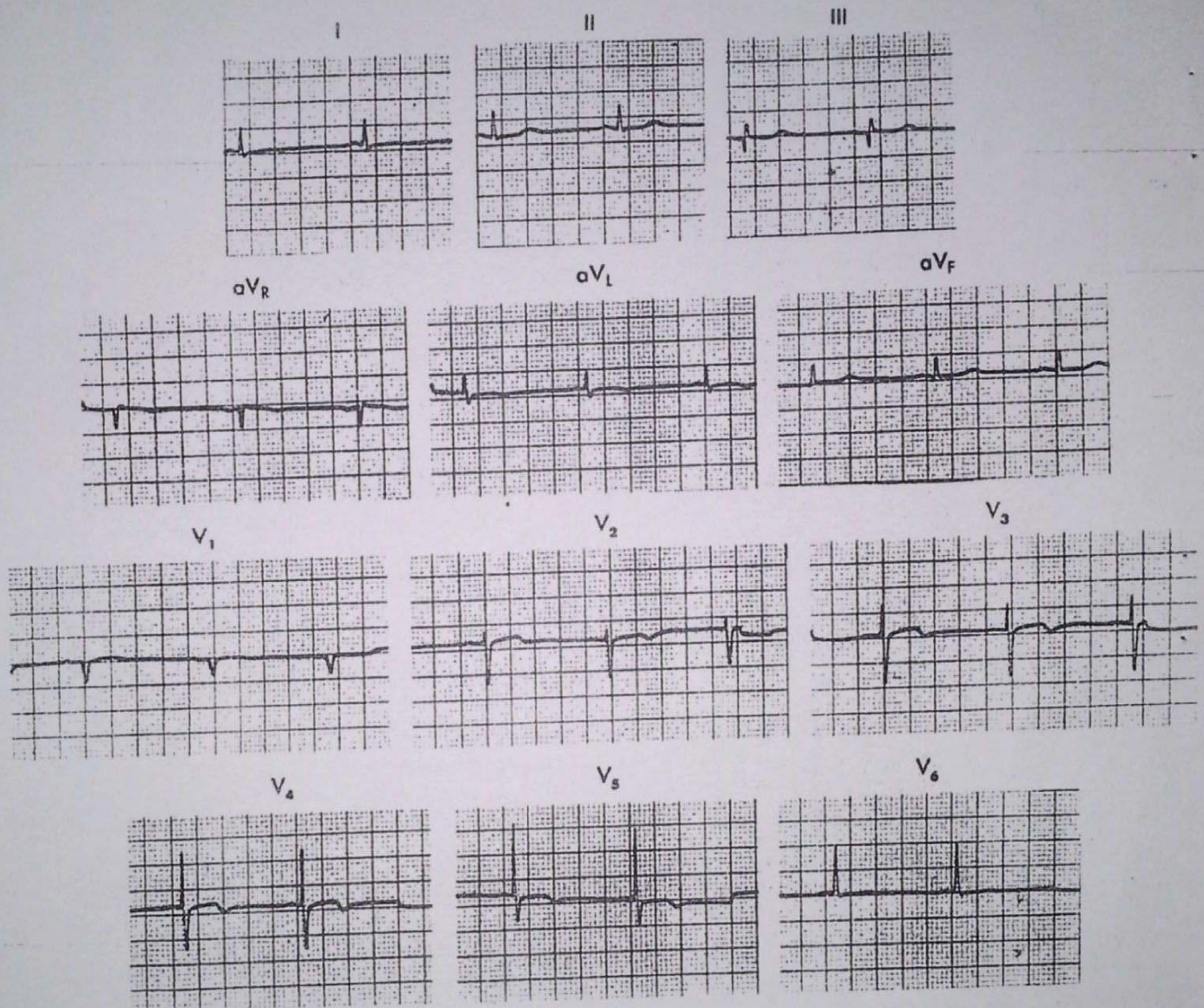
132. What is this rhythm?



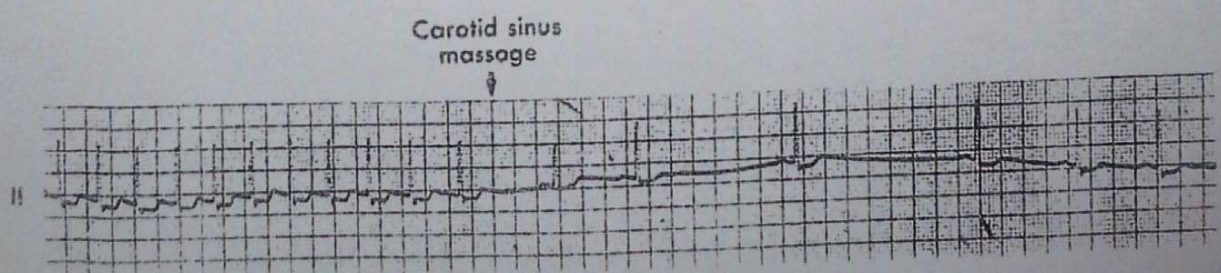
133. What arrhythmia is present here?



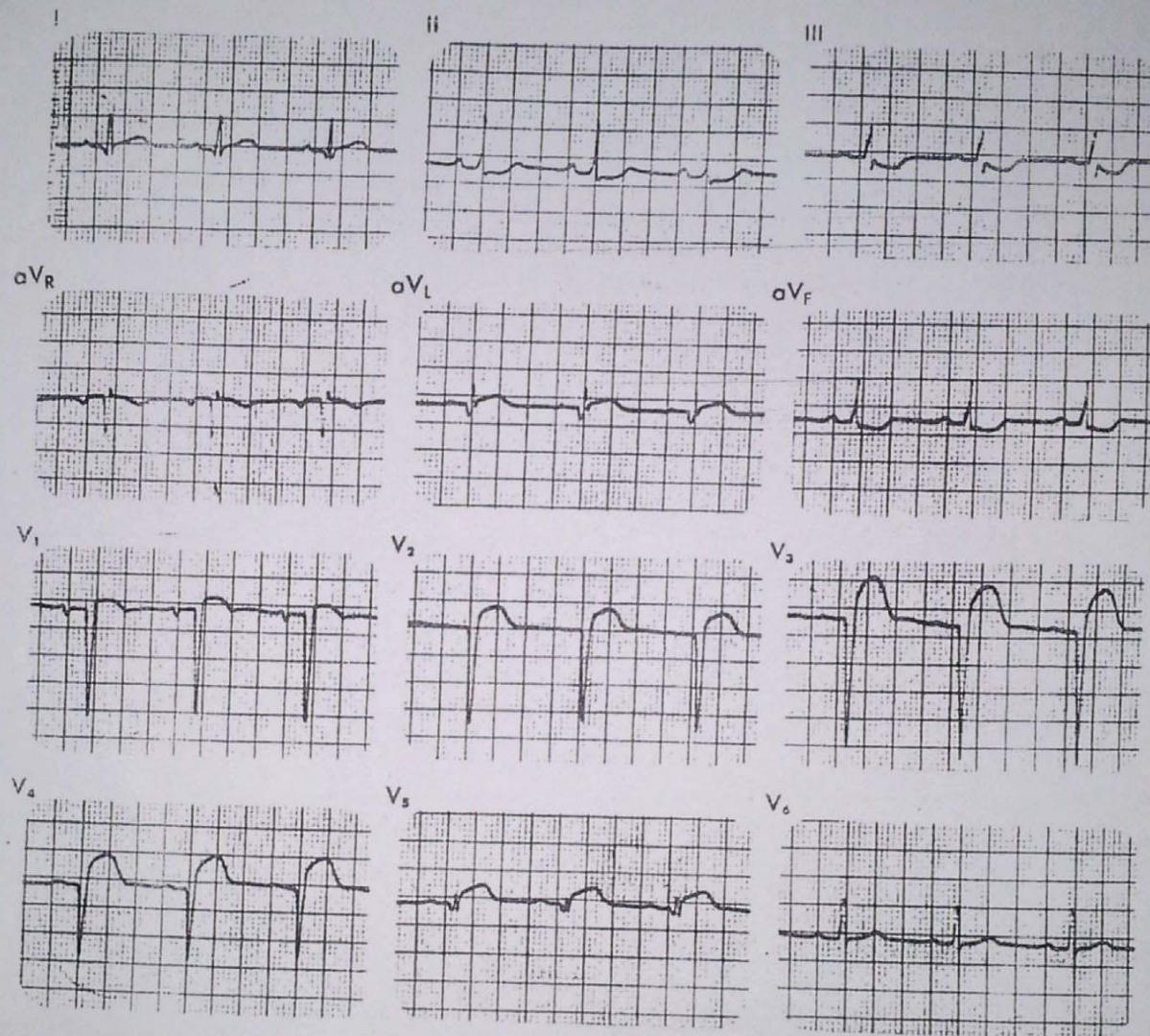
134. A 50-year-old man is complaining of chest pain. What is the likely cause of his complaint?



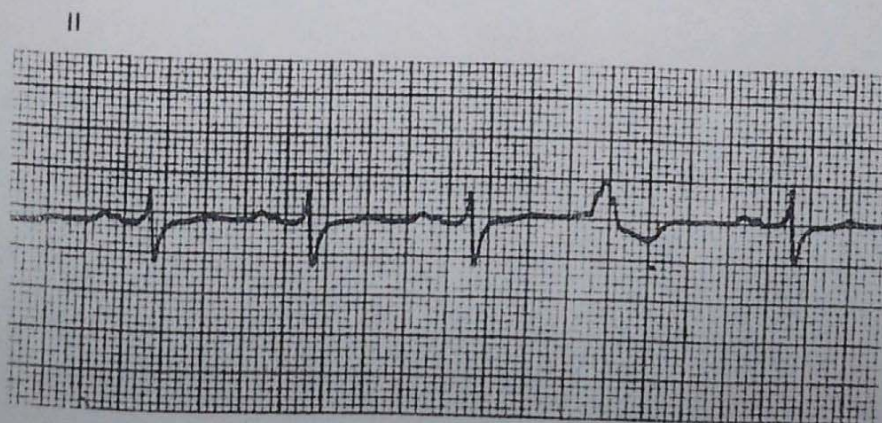
135. A patient presenting with palpitations received carotid sinus massage. What is the arrhythmia?



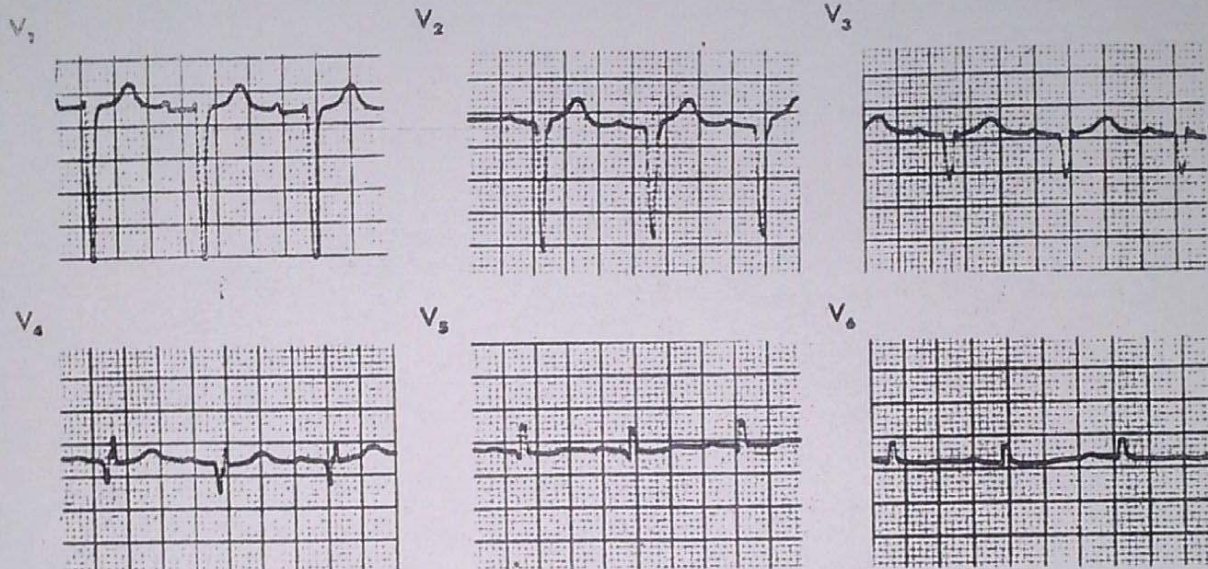
136. This patient's ECG was normal 3 days ago. What is the diagnosis from this repeat ECG?



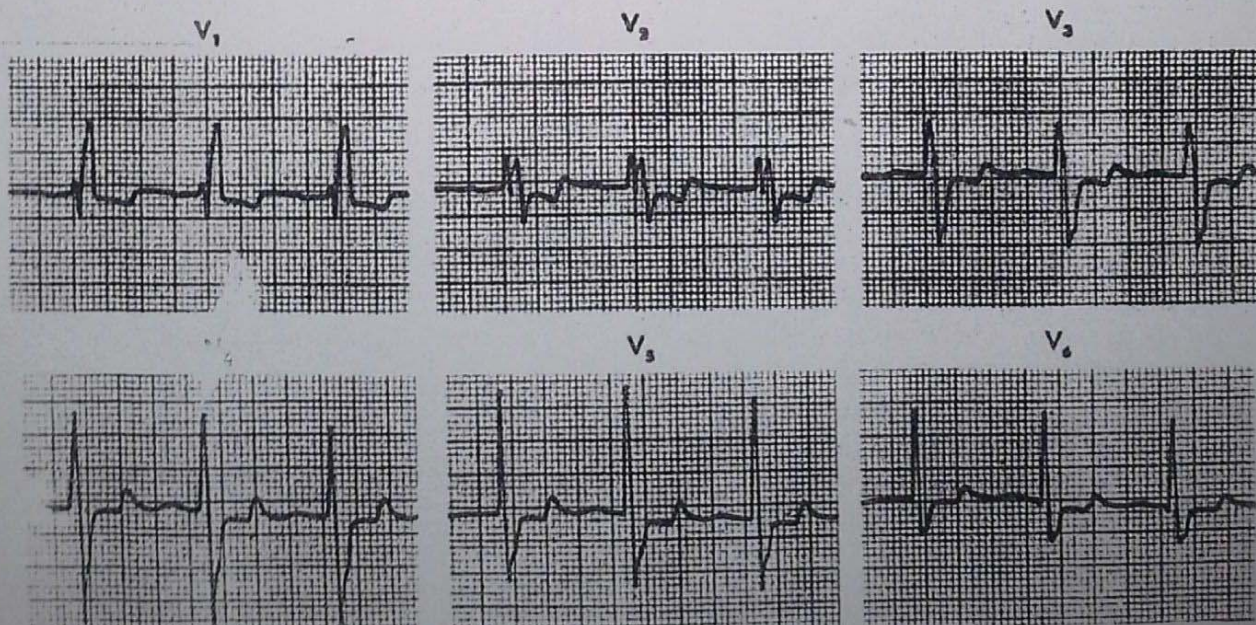
137. This lead II rhythm strip shows what three abnormalities?



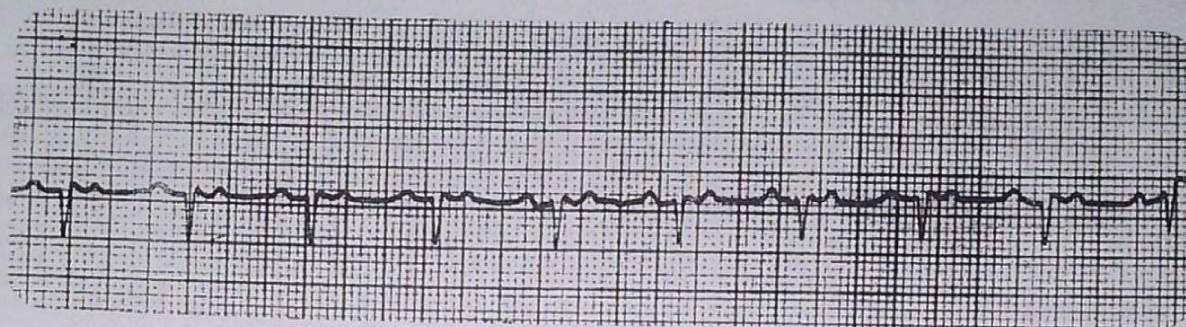
138. What is the major ECG diagnosis?



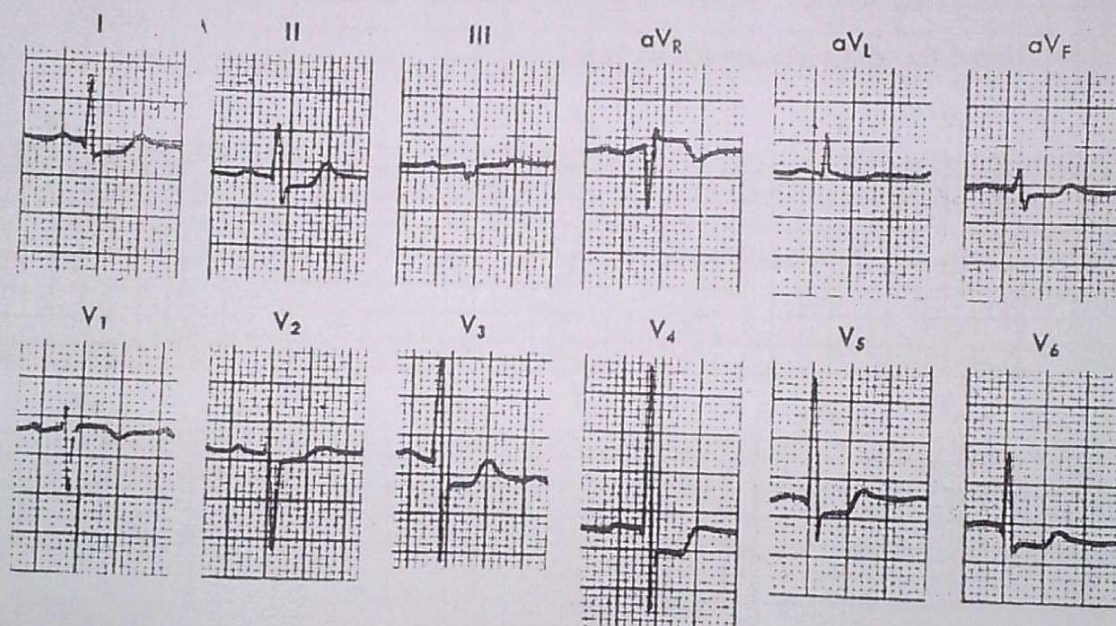
139. Name the major abnormalities here.



140. What is this subtle rhythm disturbance in a patient on digoxin therapy for congestive heart failure?

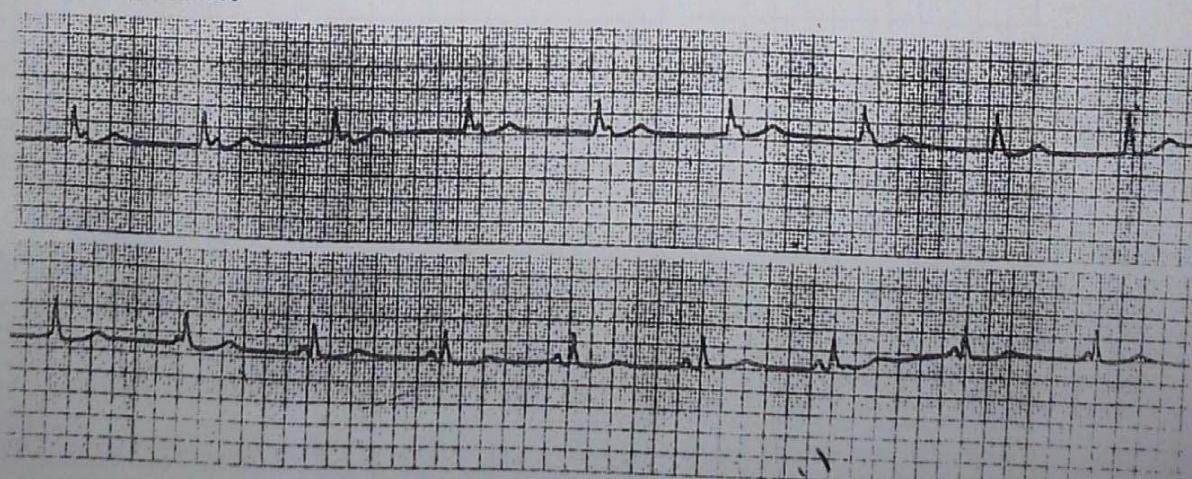


141. A 41-year-old man is complaining of "indigestion." What is the diagnosis?



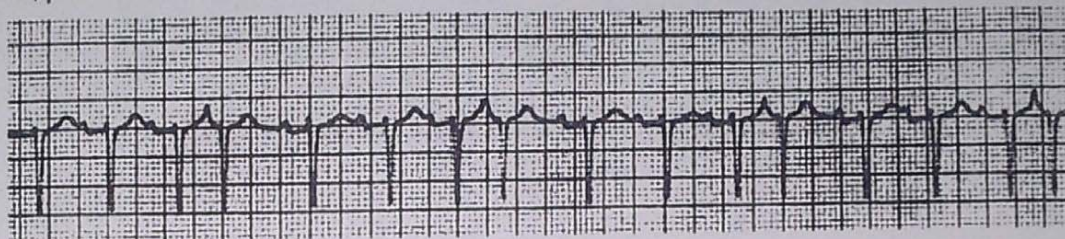
142. What is this rhythm?

Lead II: continuous



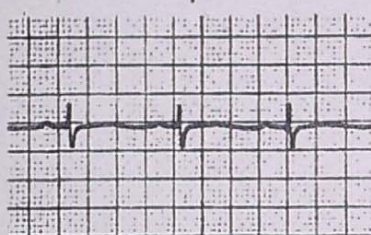
143. What is this rhythm?

V₁

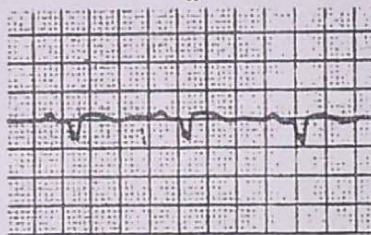


144. Name the major abnormalities here.

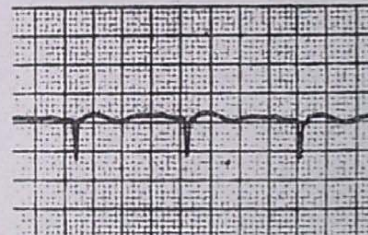
I



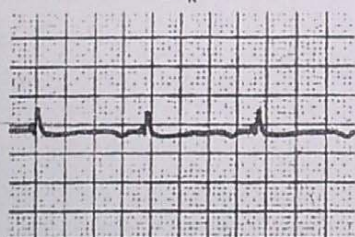
II



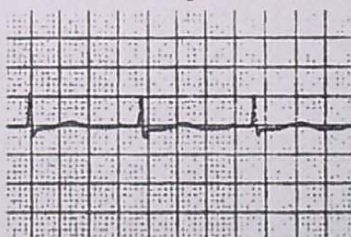
III



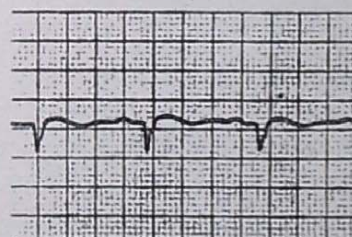
aV_R



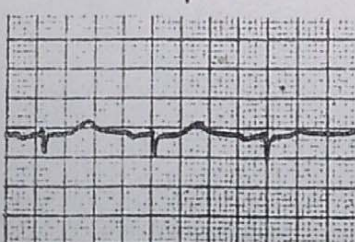
aV_L



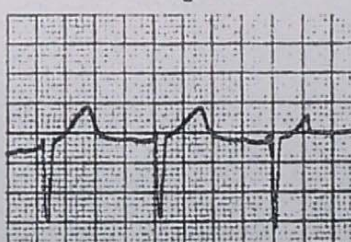
aV_F



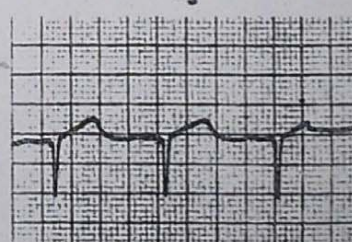
V₁



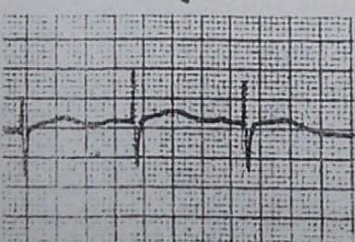
V₂



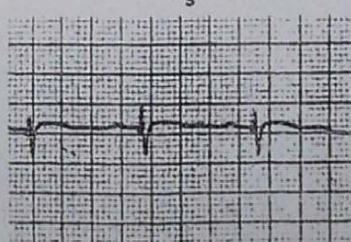
V₃



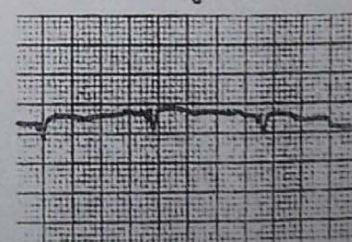
V₄



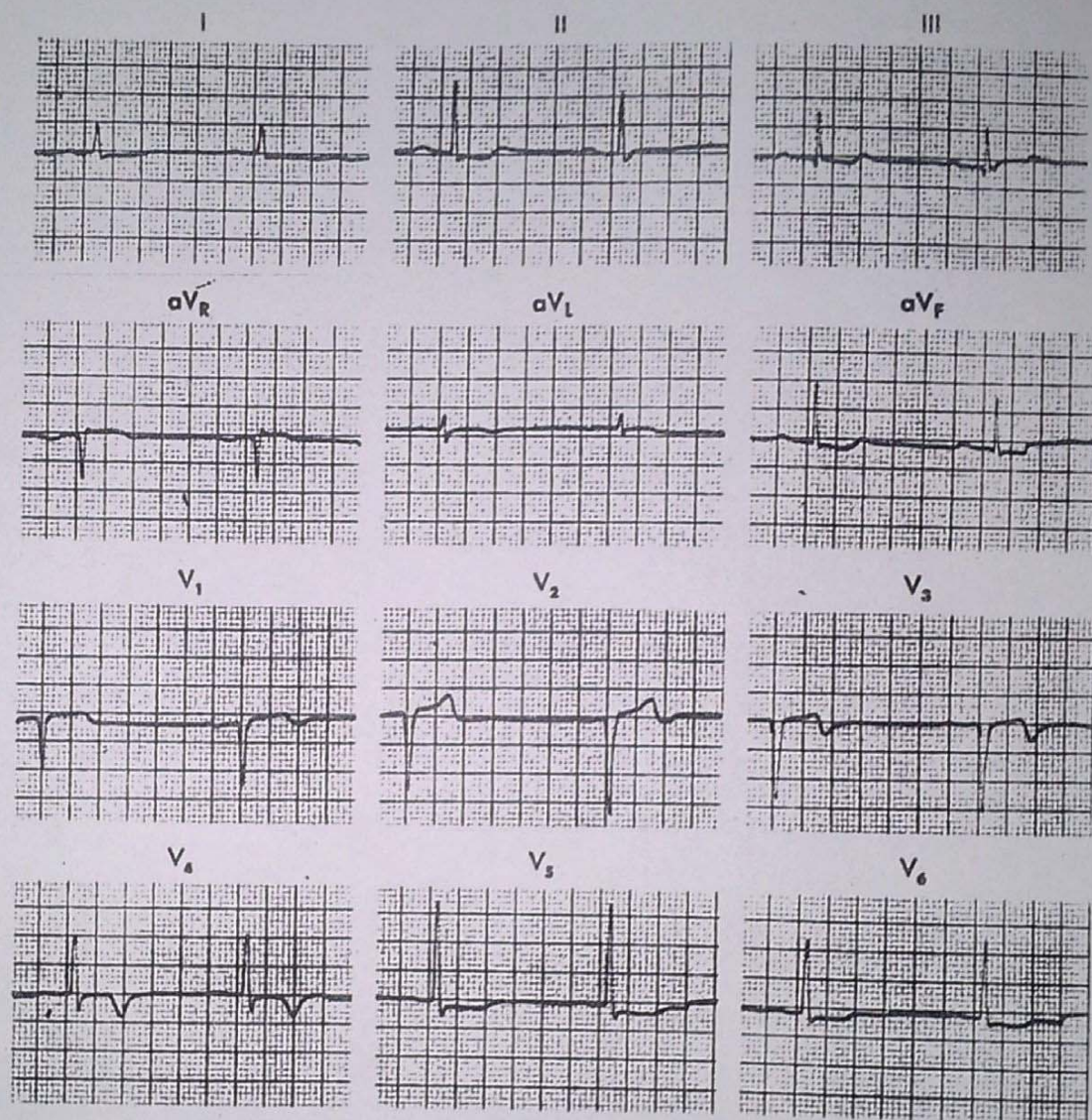
V₅



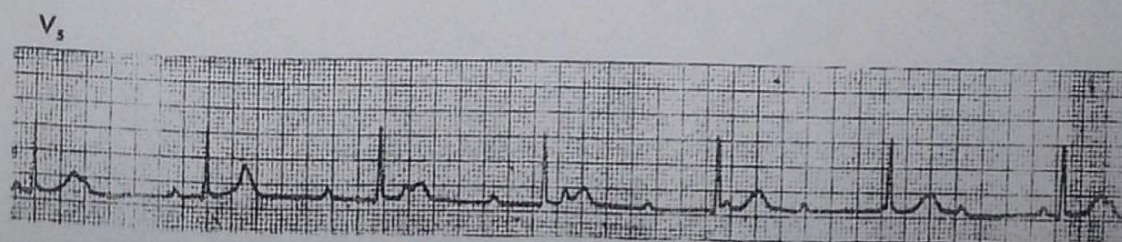
V₆



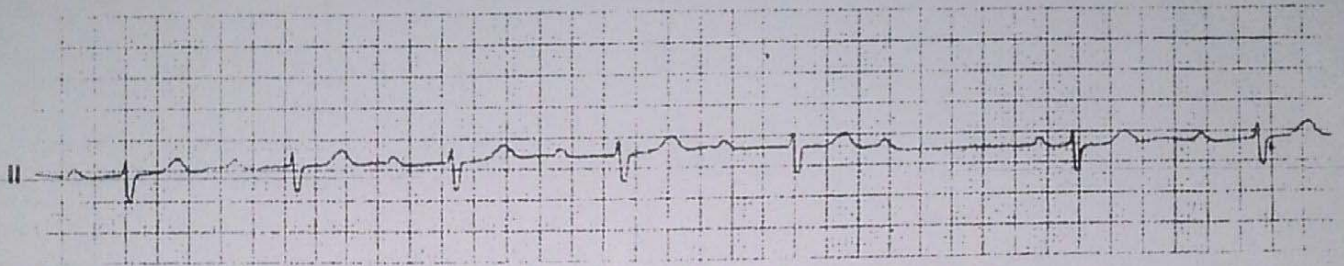
145. Name the major abnormalities here.



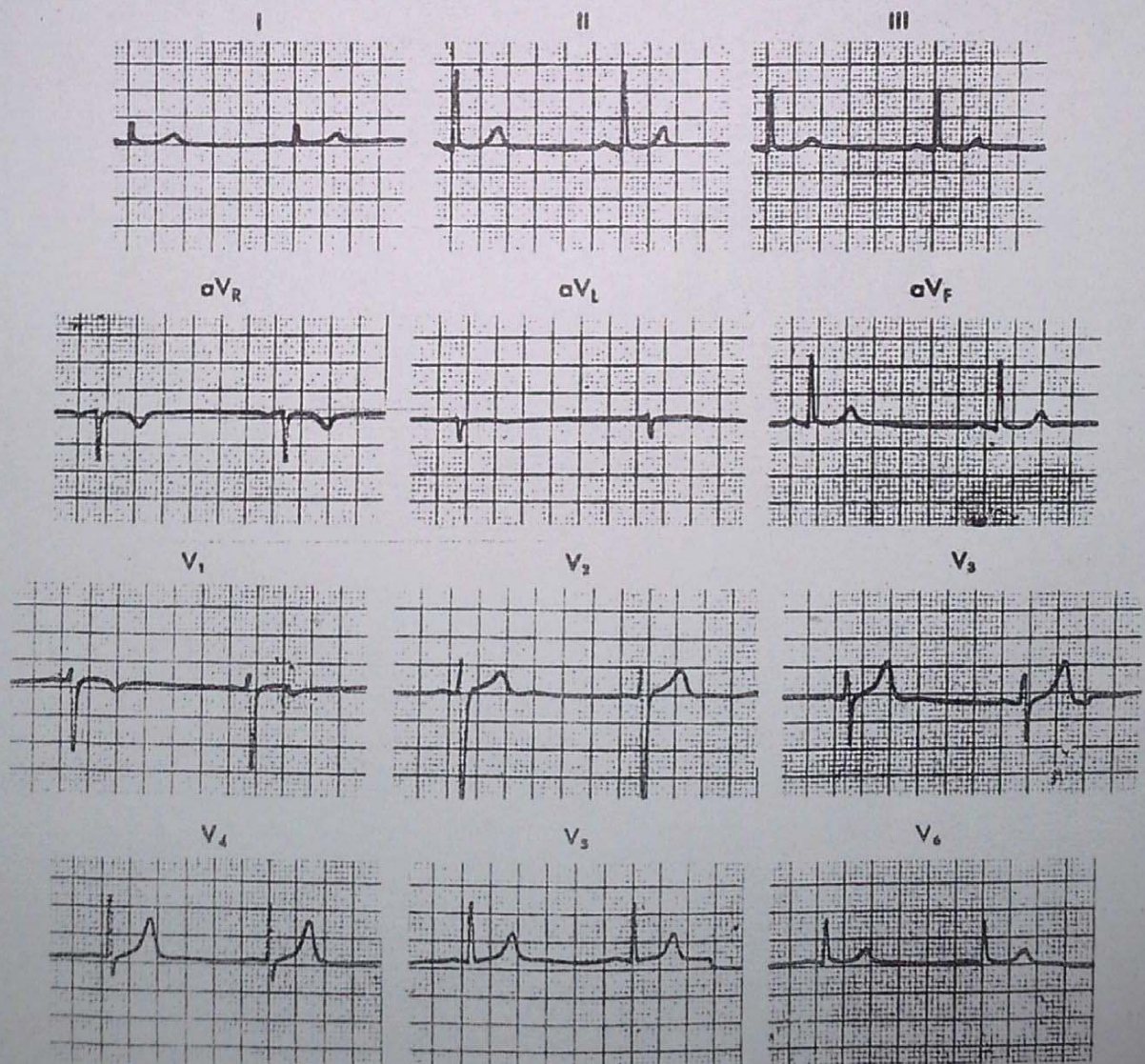
146. What is this arrhythmia?



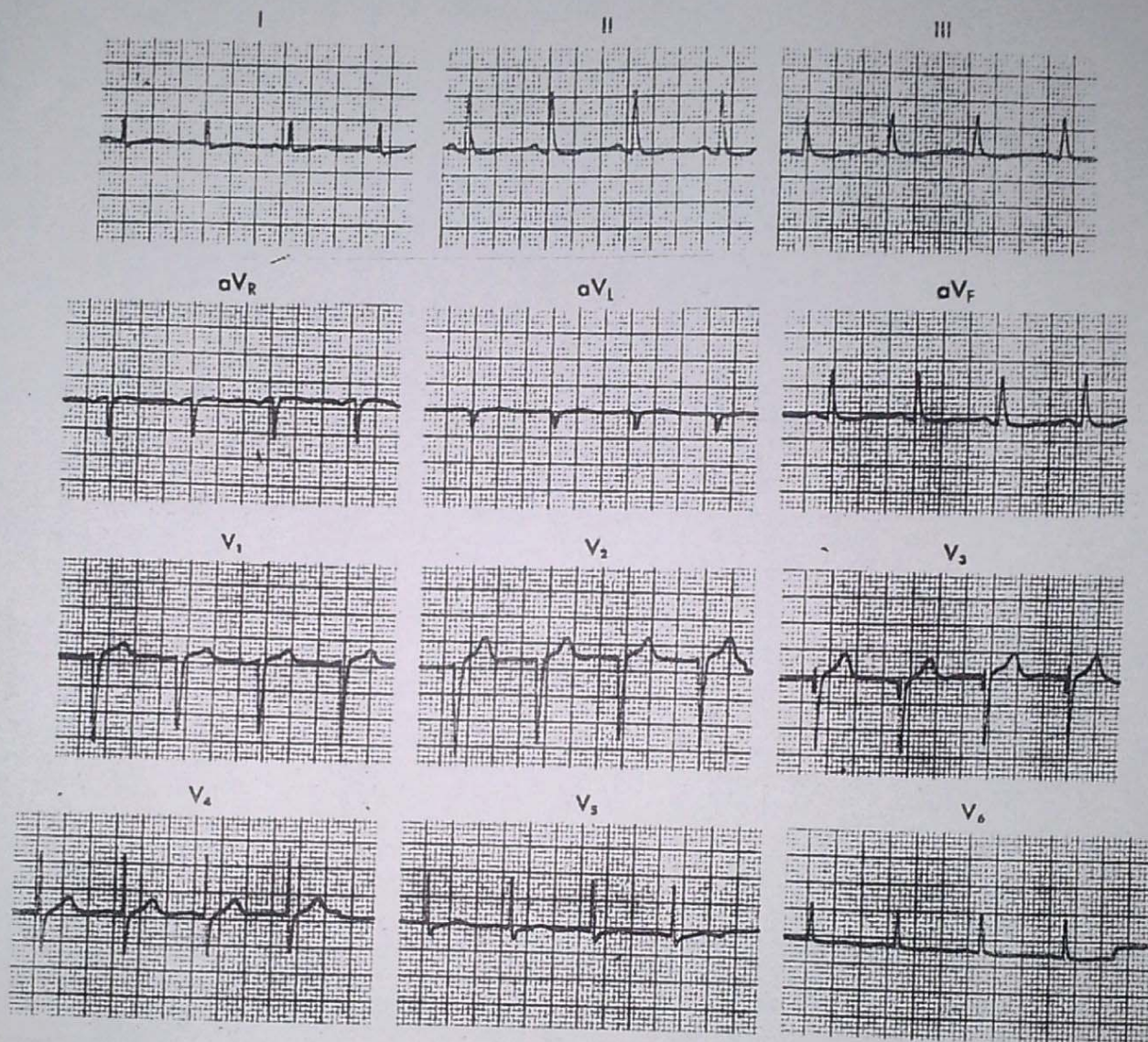
147. What is the cause of the "dropped" P wave here?



148. Following is the preoperative ECG of an athletic 45-year-old man. What is the diagnosis?

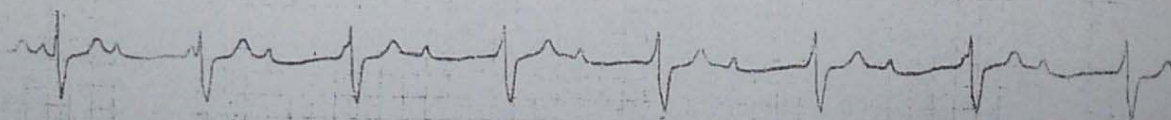


149. Following is the preoperative ECG of a 65-year-old woman. What is the diagnosis?

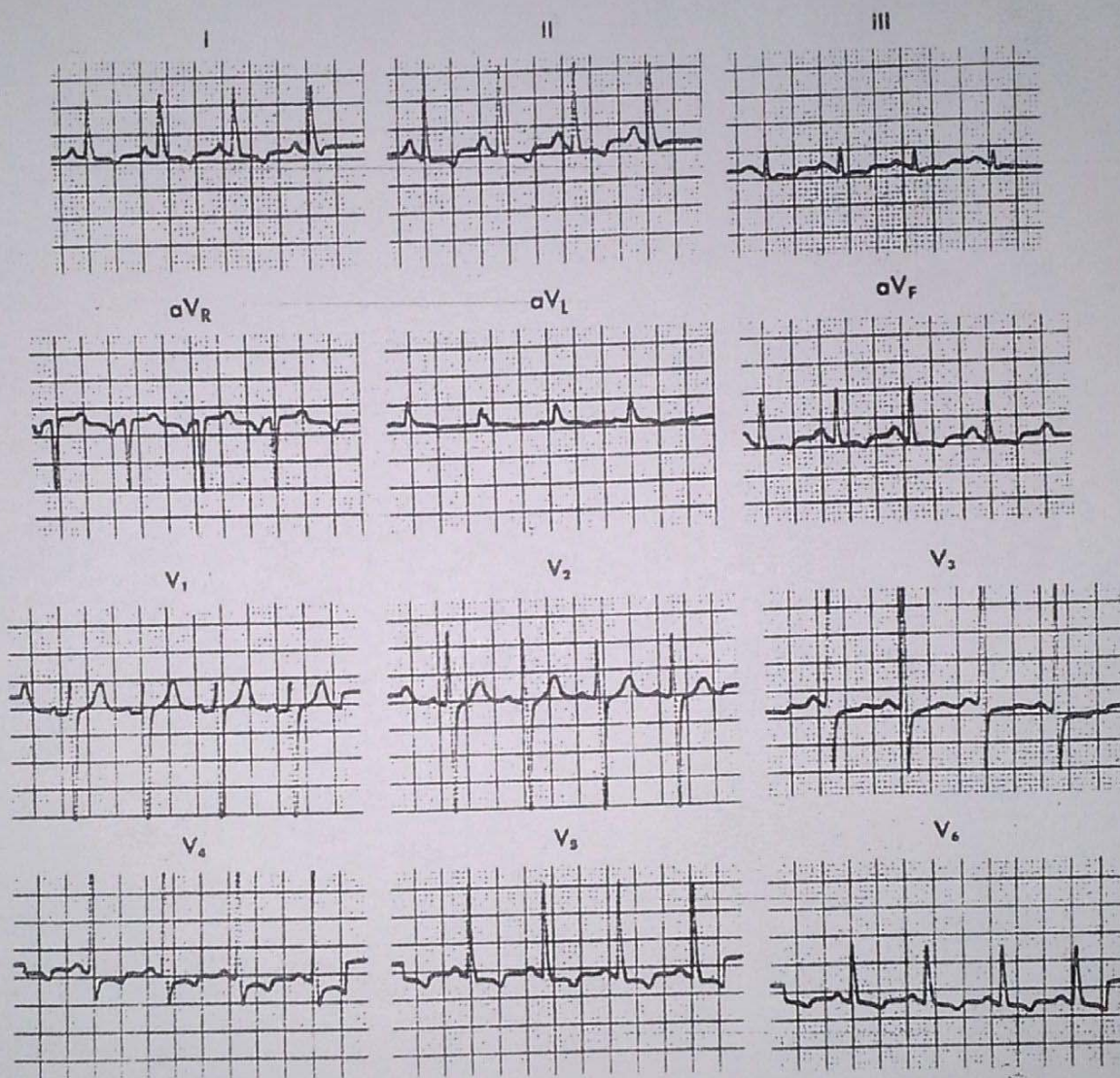


150. What caused this patient's syncope?

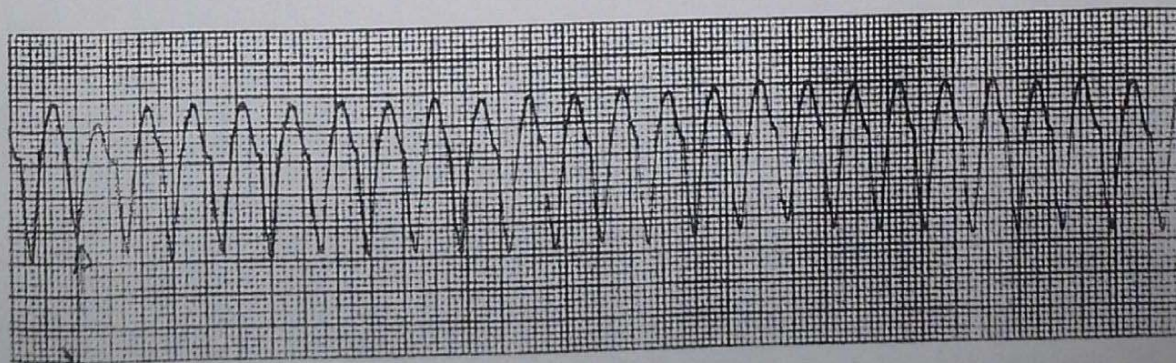
Monitor lead



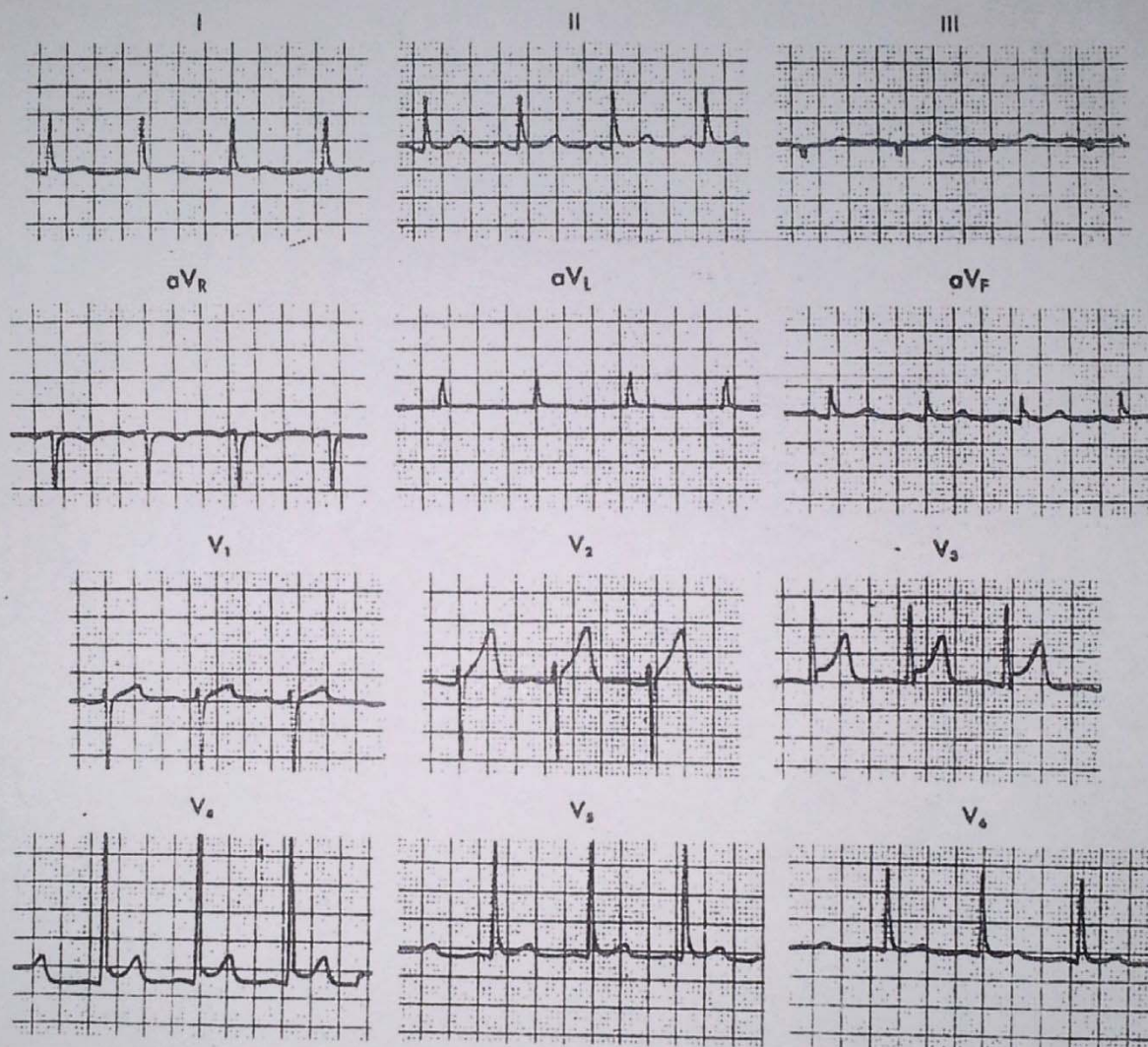
151. The following ECG is from a 60-year-old man with severe hypertension. What are the findings?



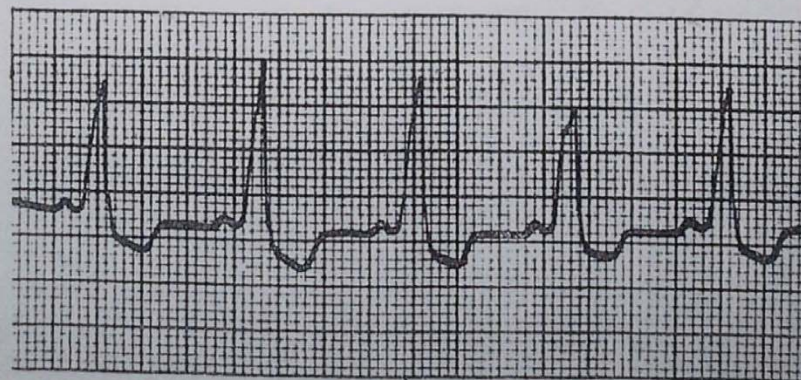
152. What is this arrhythmia?



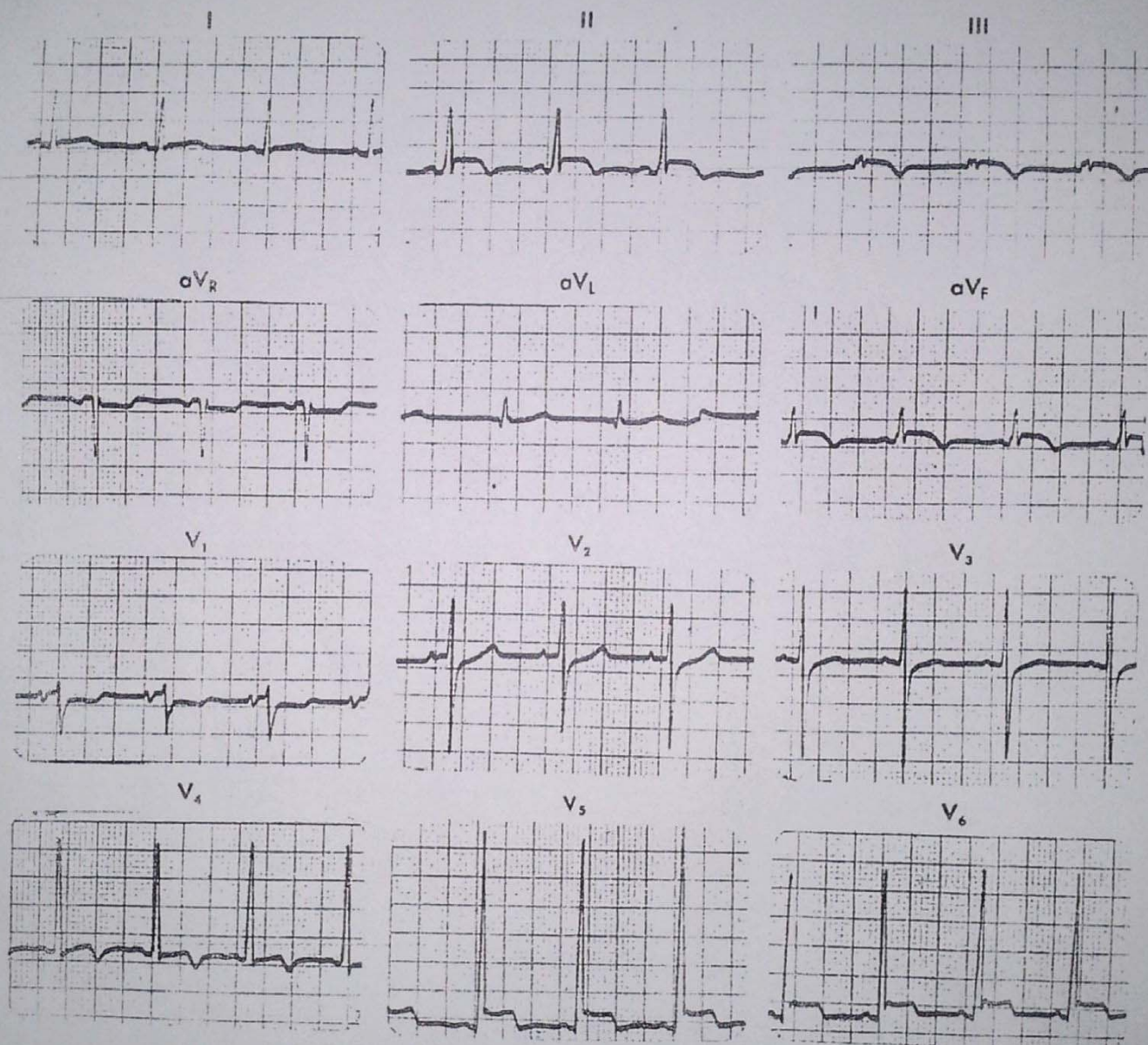
153. The following ECG is from a 24-year-old healthy male medical student. What is the diagnosis?



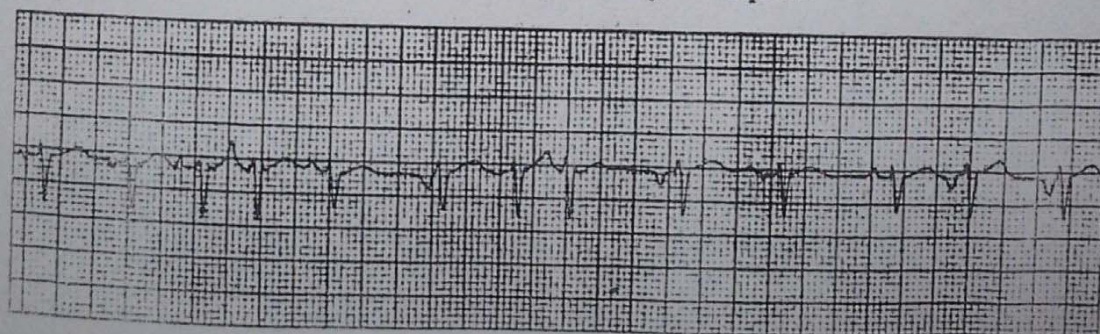
154. What is the cause of the wide QRS complexes?



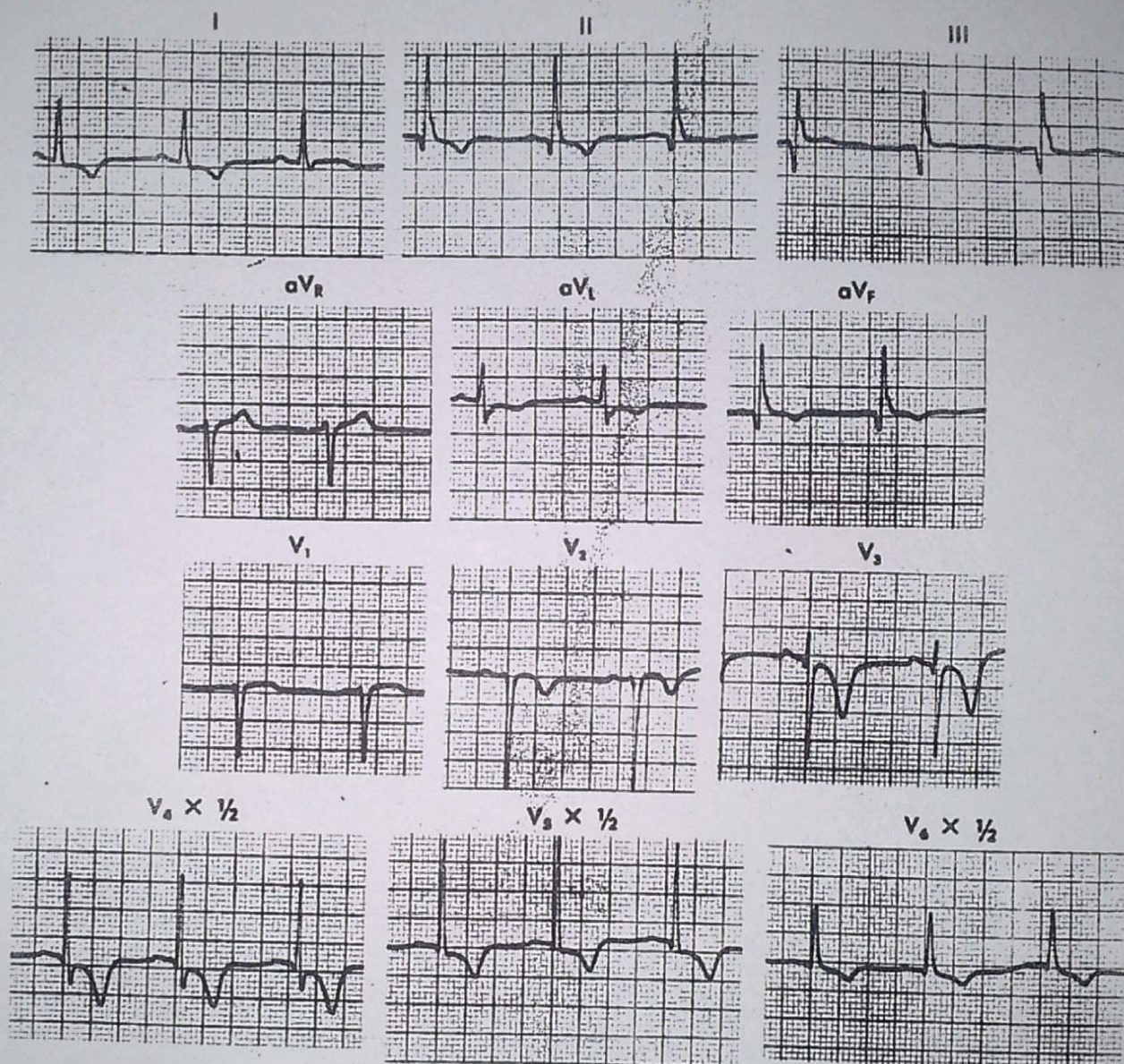
155. The following ECG is from a 50-year-old dialysis patient complaining of sharp pleuritic chest pain. What is the cause of his complaint?



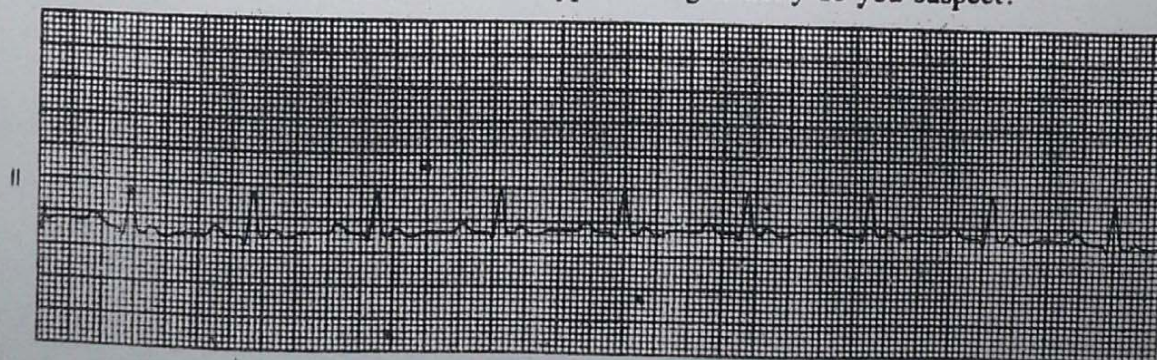
156. What is this rhythm and what clinical condition do you suspect?



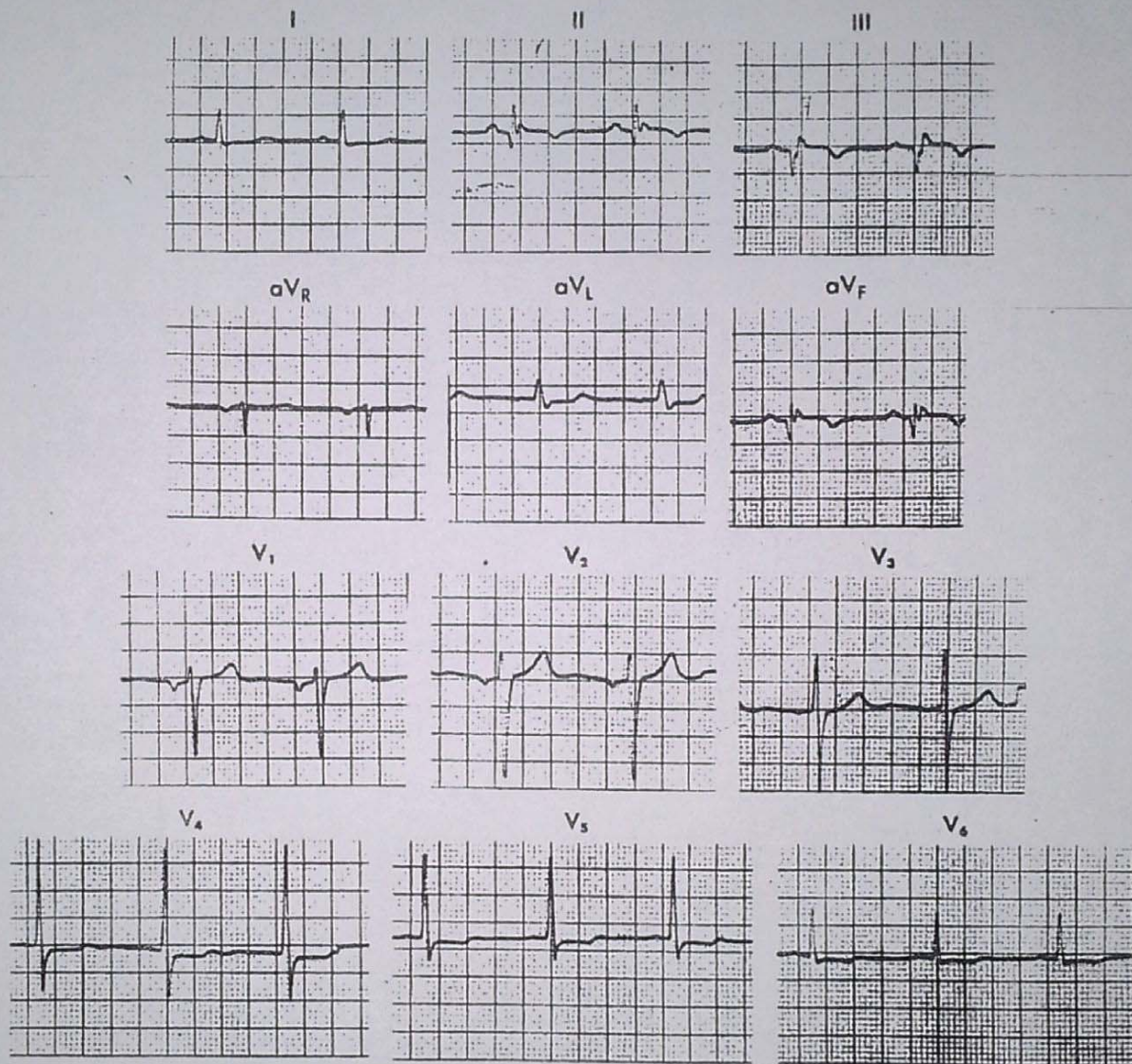
157. The following ECG is from a 62-year-old man. Describe the major abnormalities.



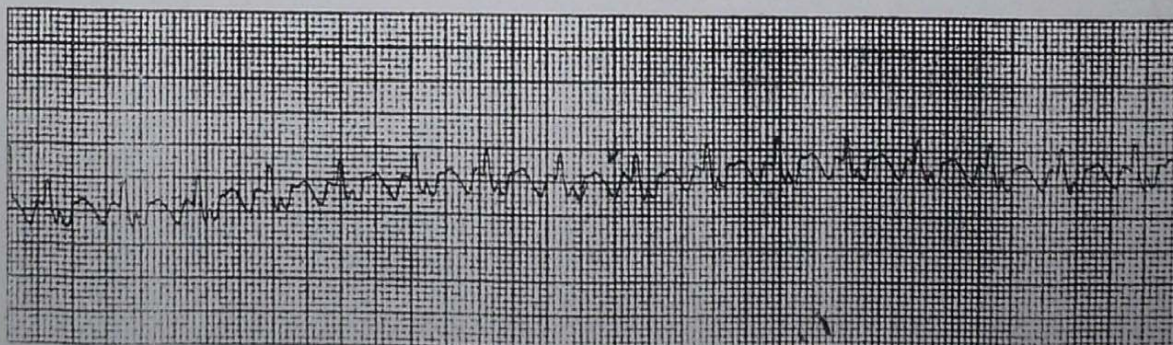
158. What is this subtle arrhythmia and what type of drug toxicity do you suspect?



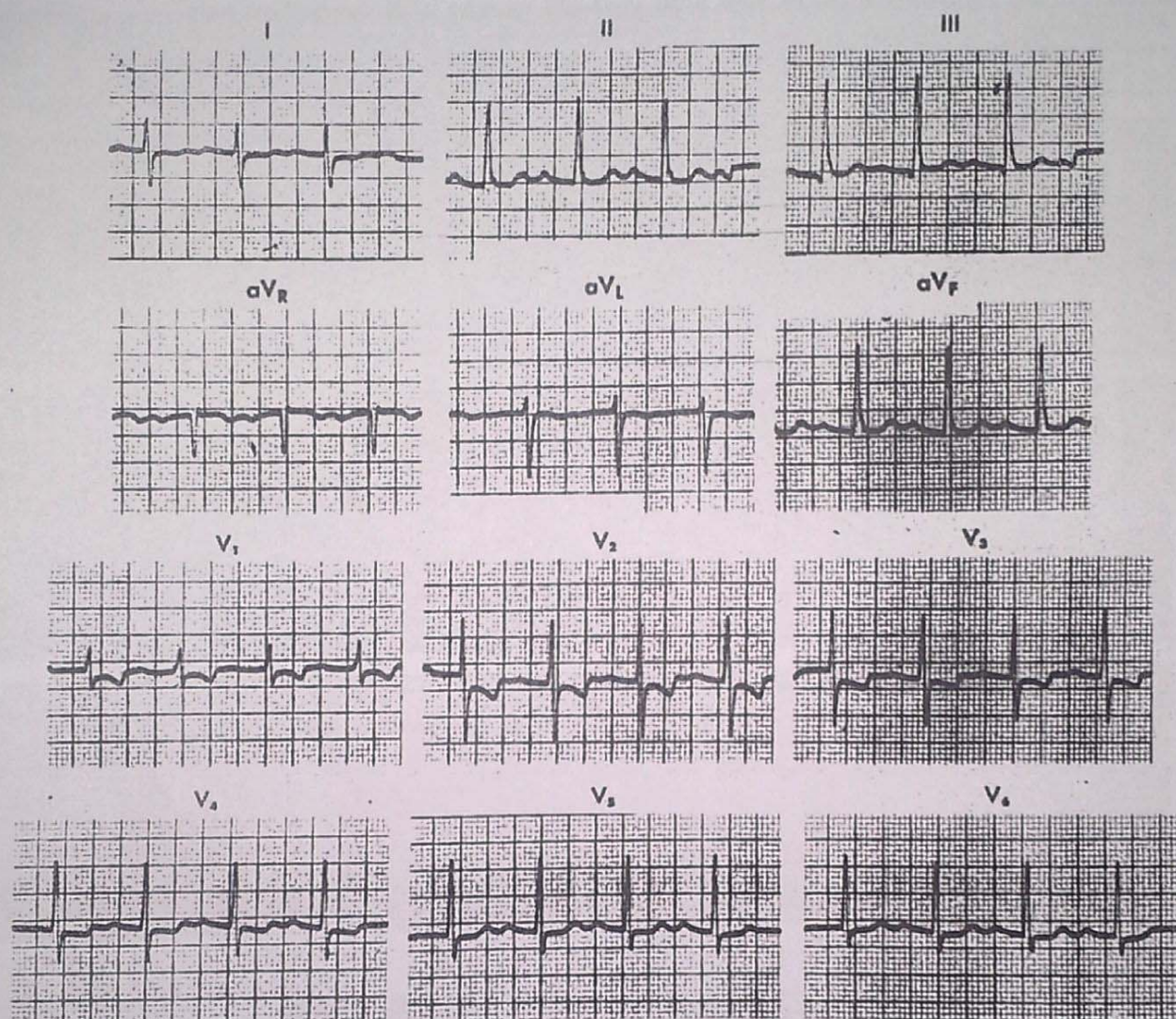
159. The following ECG is from a 59-year-old woman. Describe the major findings.



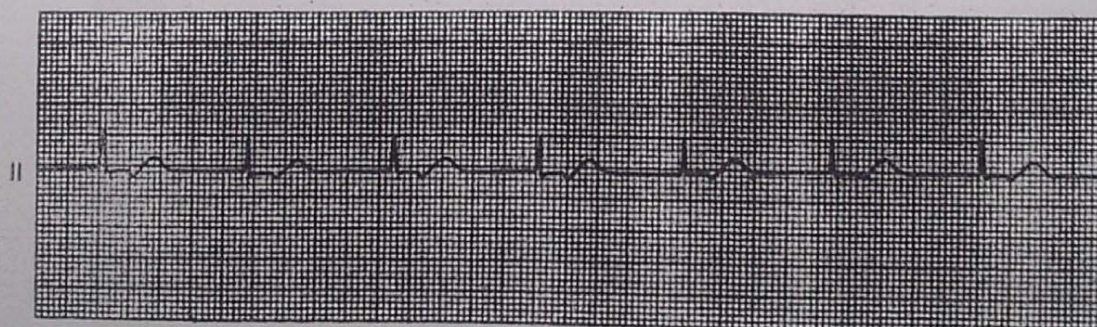
160. What is this rhythm?



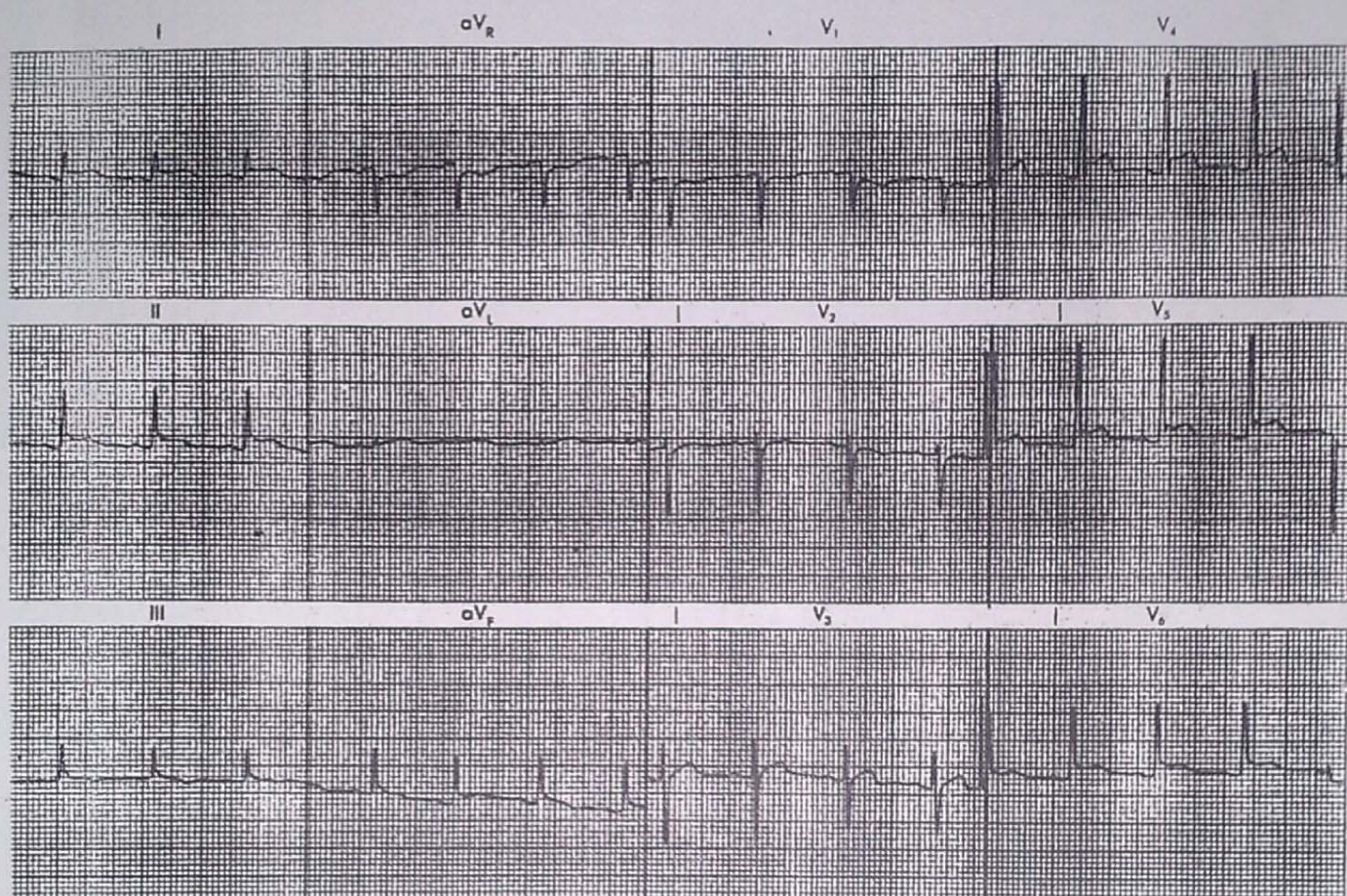
161. The following ECG is from a 50-year-old woman with suspected recurrent pulmonary emboli. What are the major abnormalities?



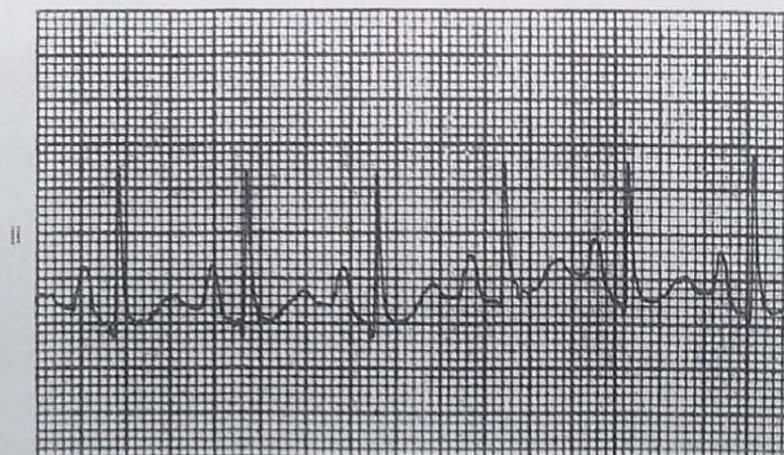
162. What is this rhythm?



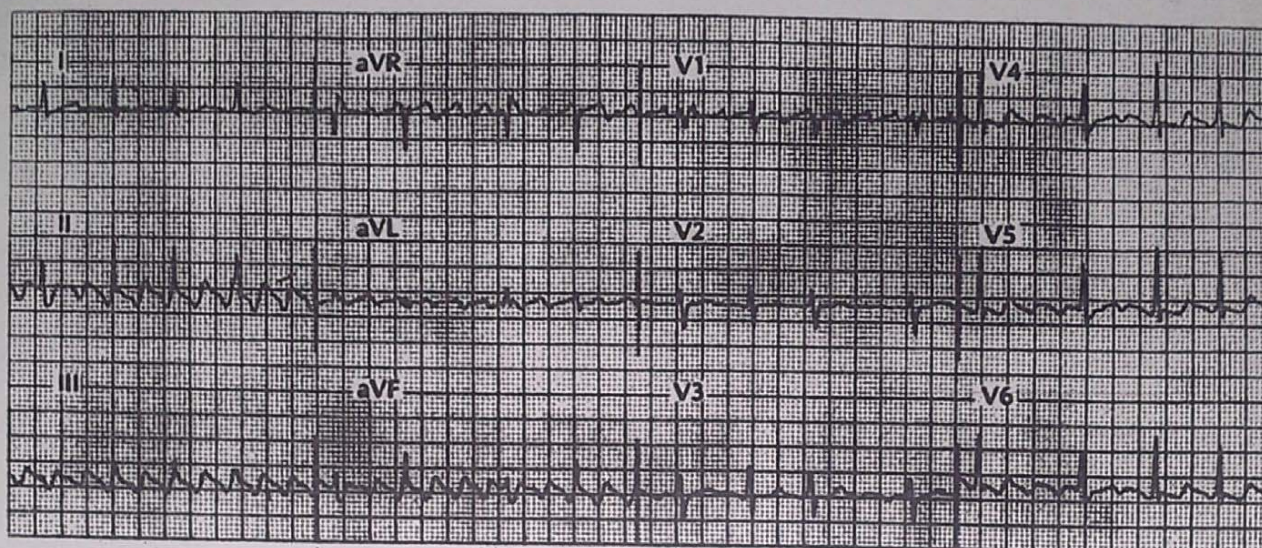
163. The following ECG is from a 20-year-old woman with sharp chest pain. What is the diagnosis?



164. What are the notable findings here?

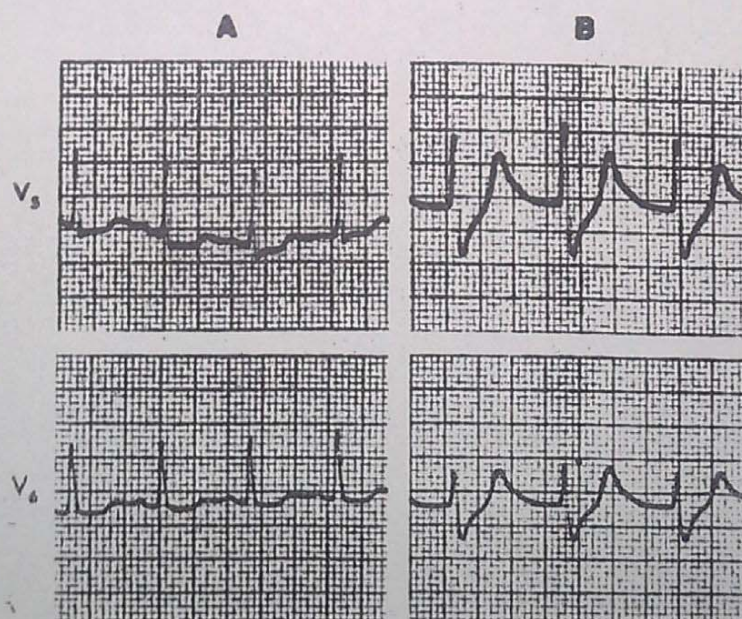


165. What arrhythmia is causing this patient's palpitations?

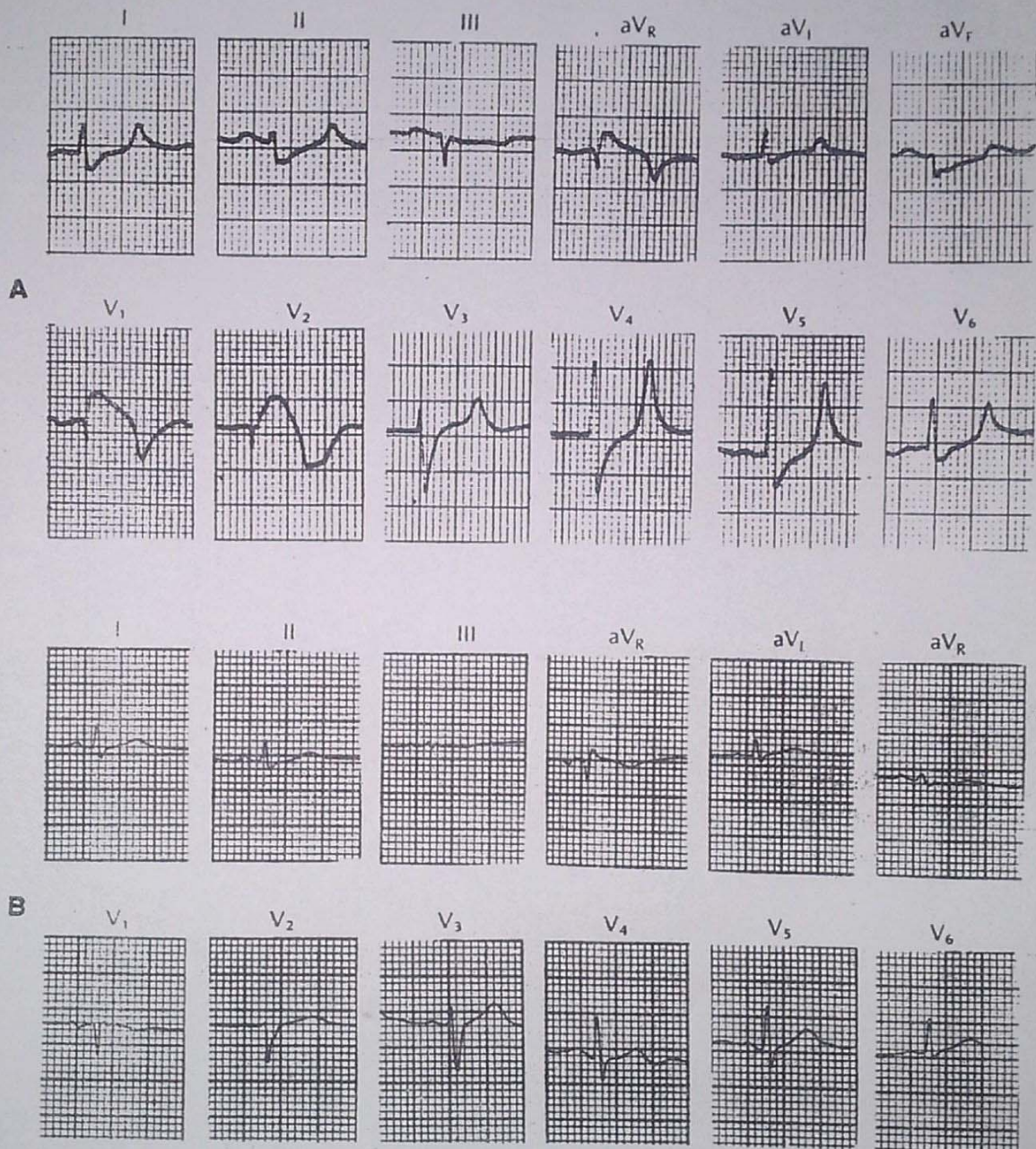


166. What factor is most likely to have caused the change from A to B?

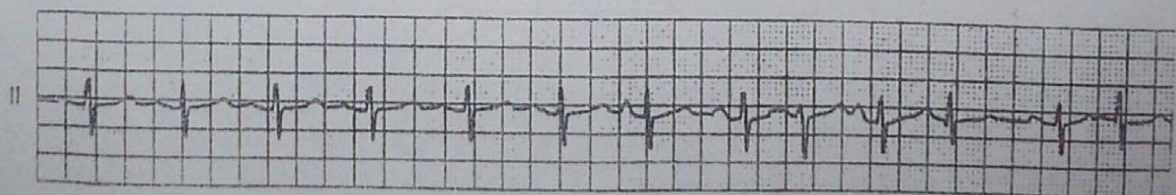
- a. Hypocalcemia
- b. Hyperkalemia
- c. Hypokalemia
- d. Digitalis



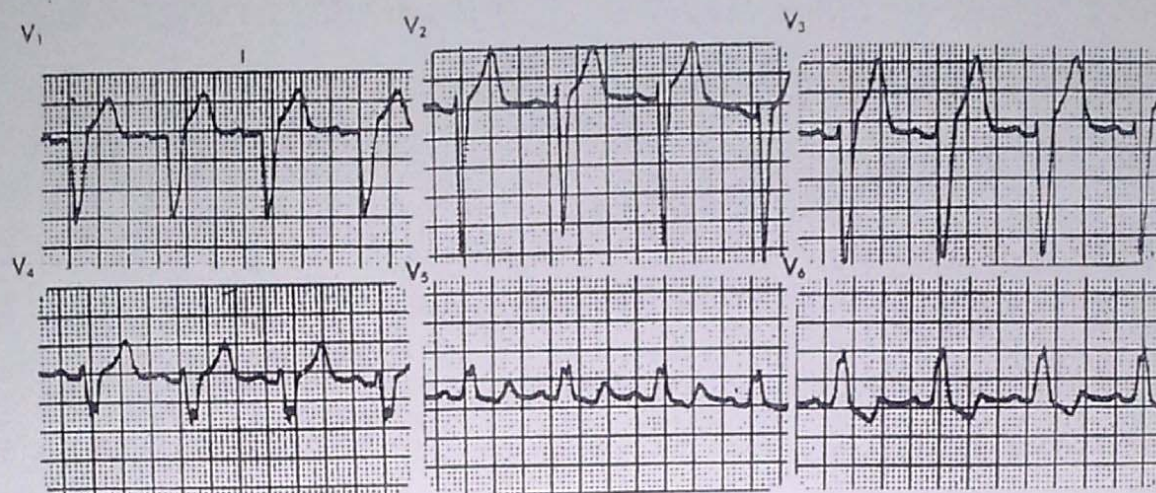
167. What metabolic problem was corrected in this patient, accounting for the marked change on the ECG from one day, A, to the next, B?



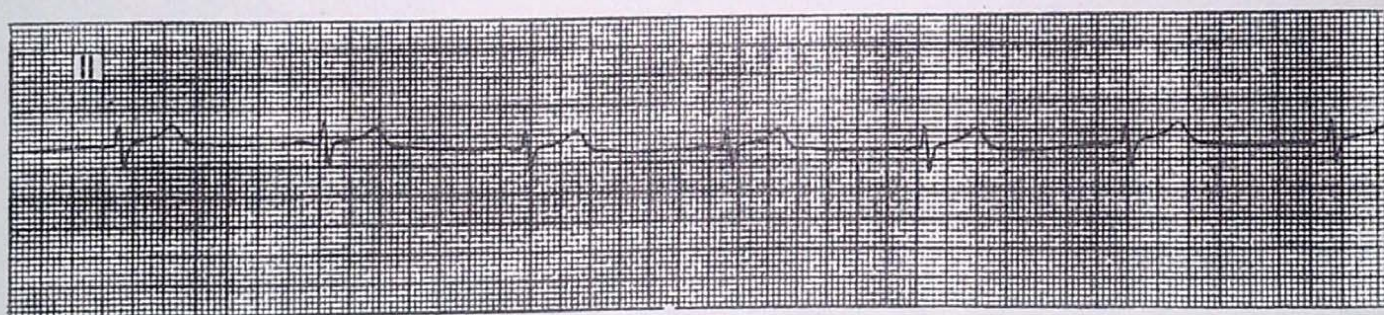
168. A 76-year-old woman complains that her "heart skips beats." What does her rhythm strip show?



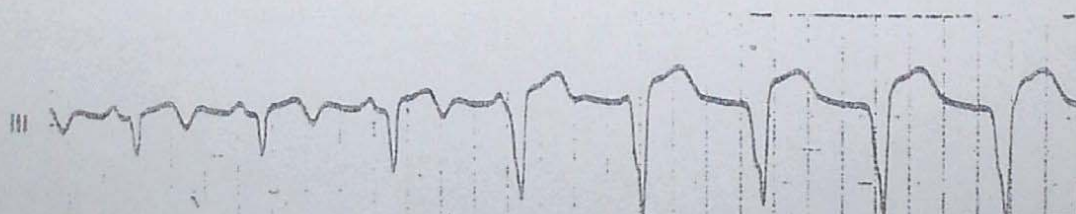
169. What type of conduction disturbance is present here?



170. This patient's bradycardia is associated with what subtle arrhythmia?



171. A patient with an evolving inferior infarction has intermittent wide QRS complexes. What are these beats?

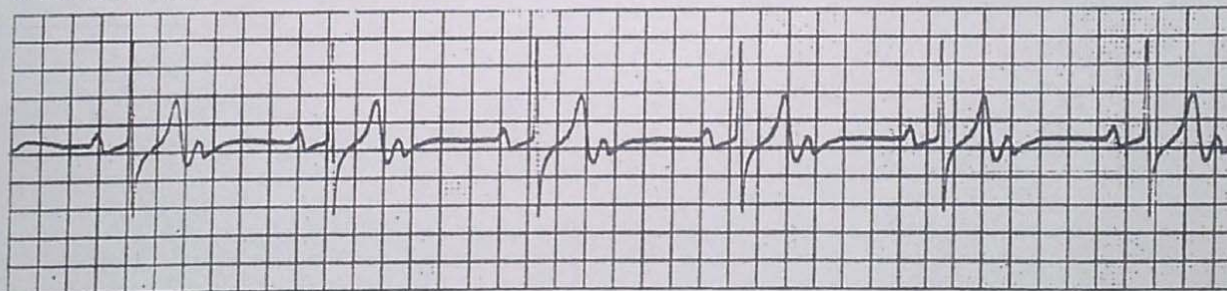


172. A 44-year-old woman with a history of intermittent atrial fibrillation complains of palpitations. What drug is she probably taking, and what is the arrhythmia?

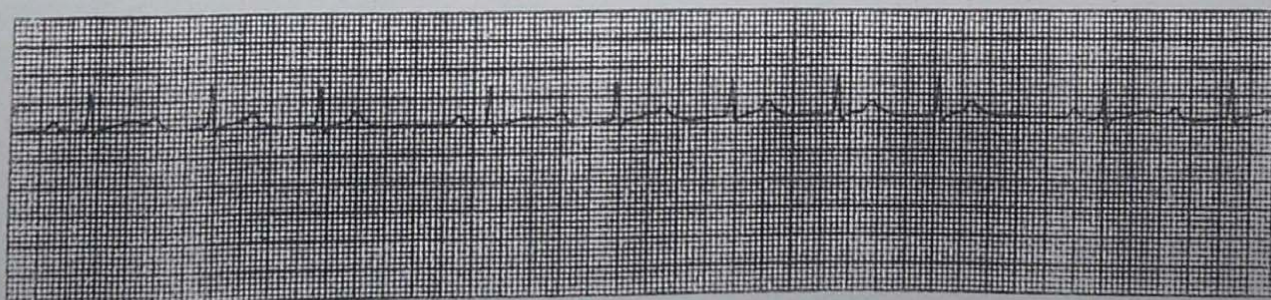


173. A 70-year-old man taking propranolol for hypertension comes to the emergency room complaining of light-headedness and weakness for the past week. What does his monitor lead rhythm strip show?

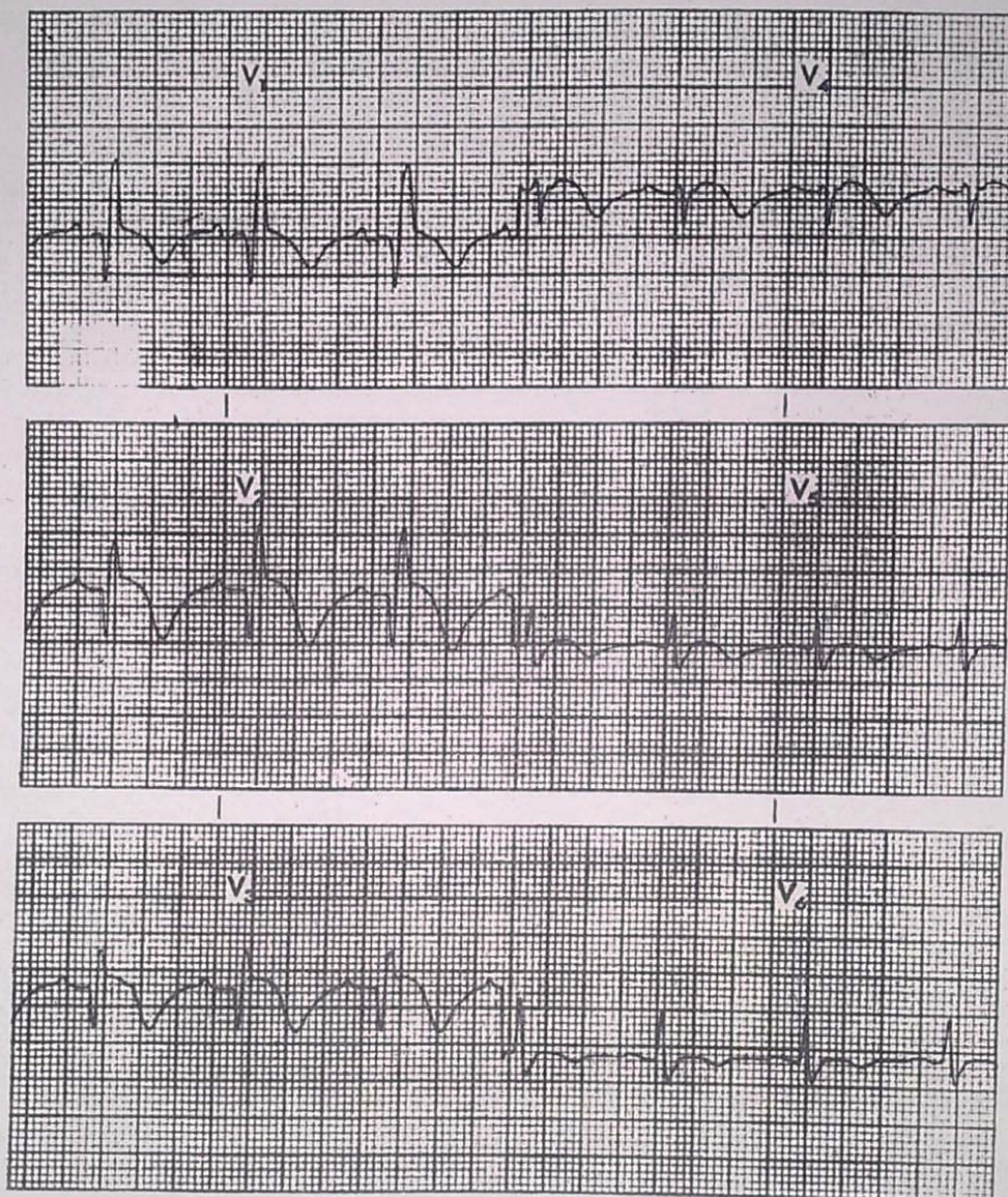
MONITOR LEAD



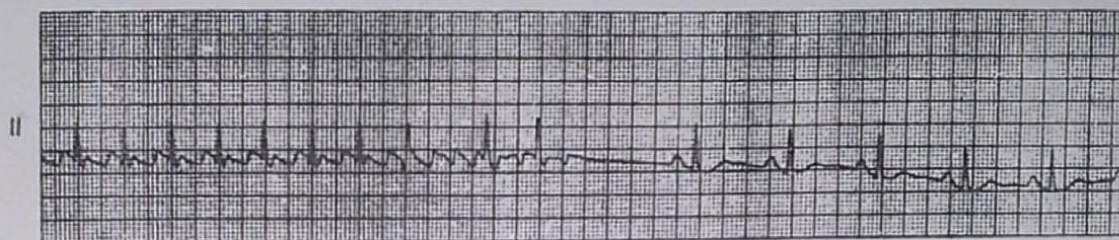
174. A 70-year-old man was given verapamil for treatment of angina. What does his rhythm strip show?



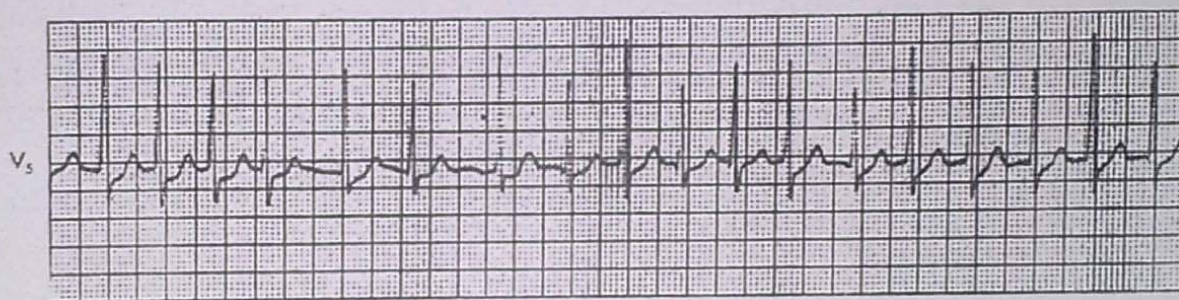
175. This patient with pulmonary edema that developed over 2 days is being seen in the emergency room. What are the major ECG findings?



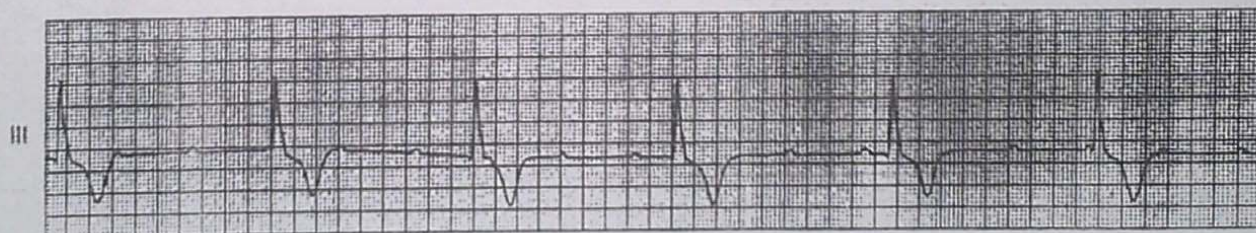
176. A 48-year-old man complains of intermittent palpitations.
What arrhythmia does he have?



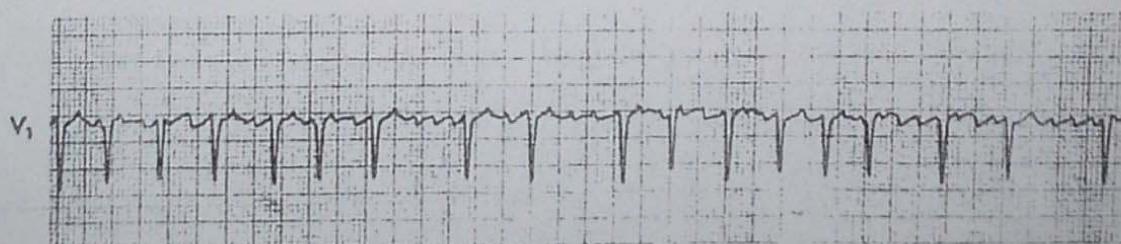
177. An acute left hemiparesis developed in a 72-year-old man.
What etiology does his ECG suggest?



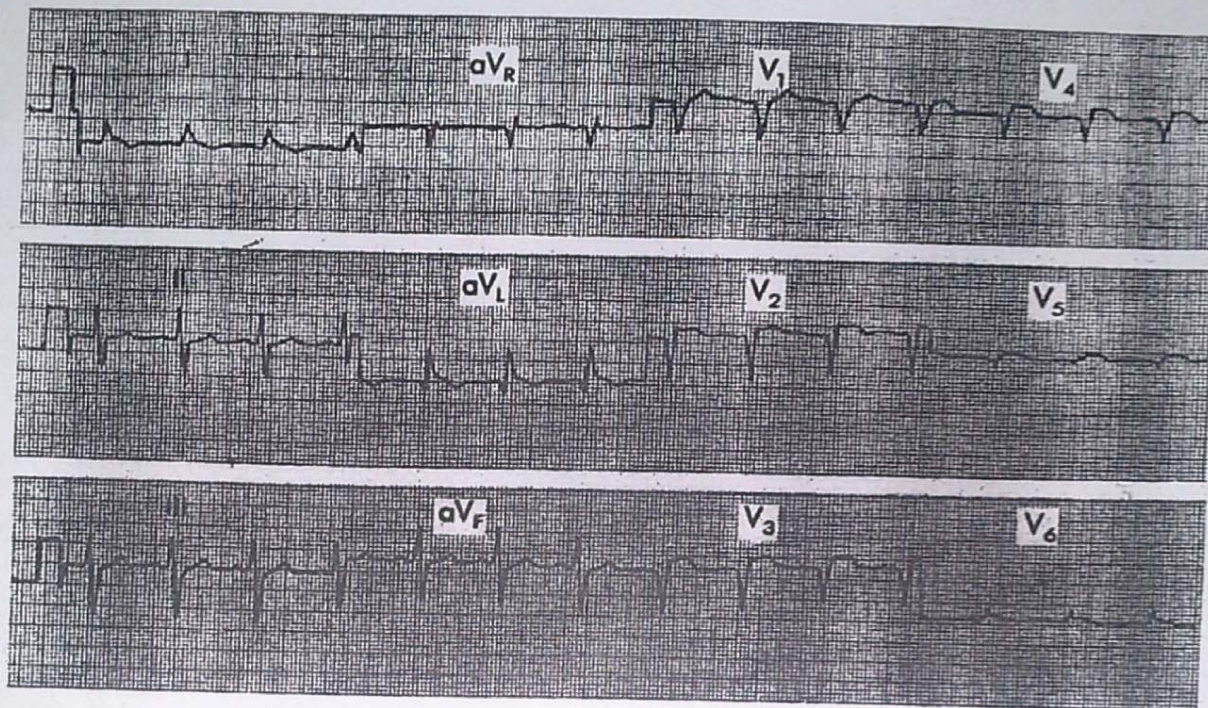
178. A 92-year-old man loses consciousness while eating dinner.
What does his rhythm strip indicate?



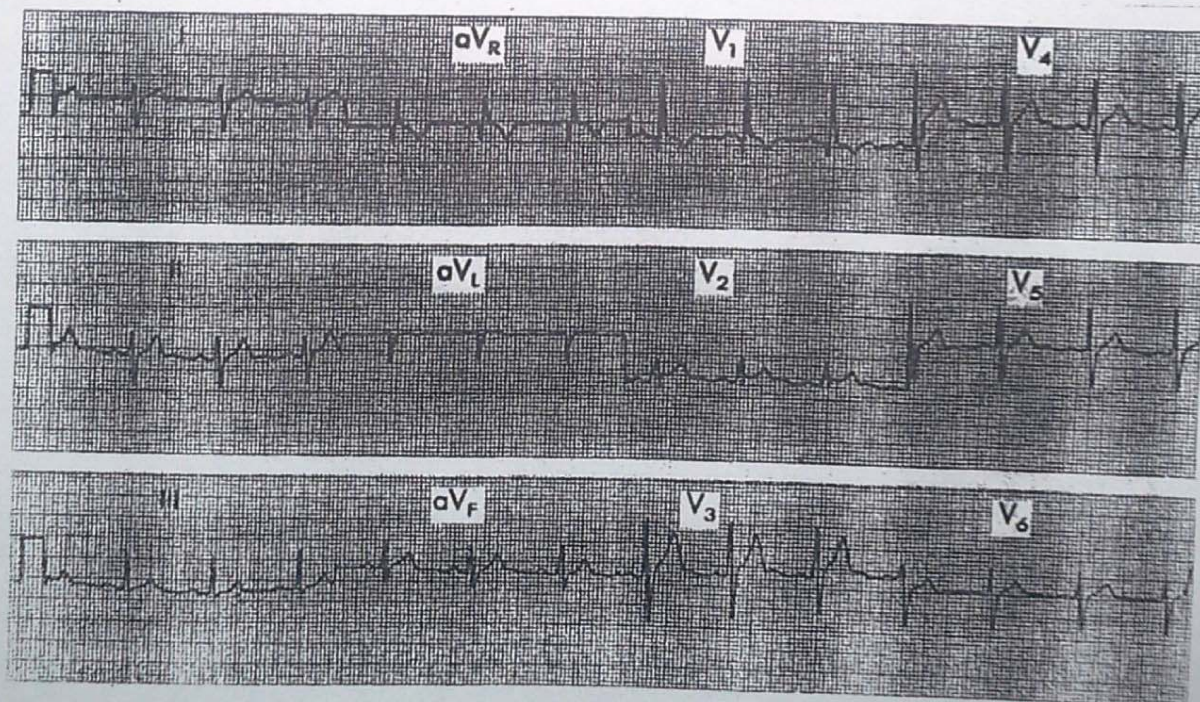
179. A 54-year-old psychiatrist complains of sudden palpitations after an argument with a "significant other." What does his ECG show?



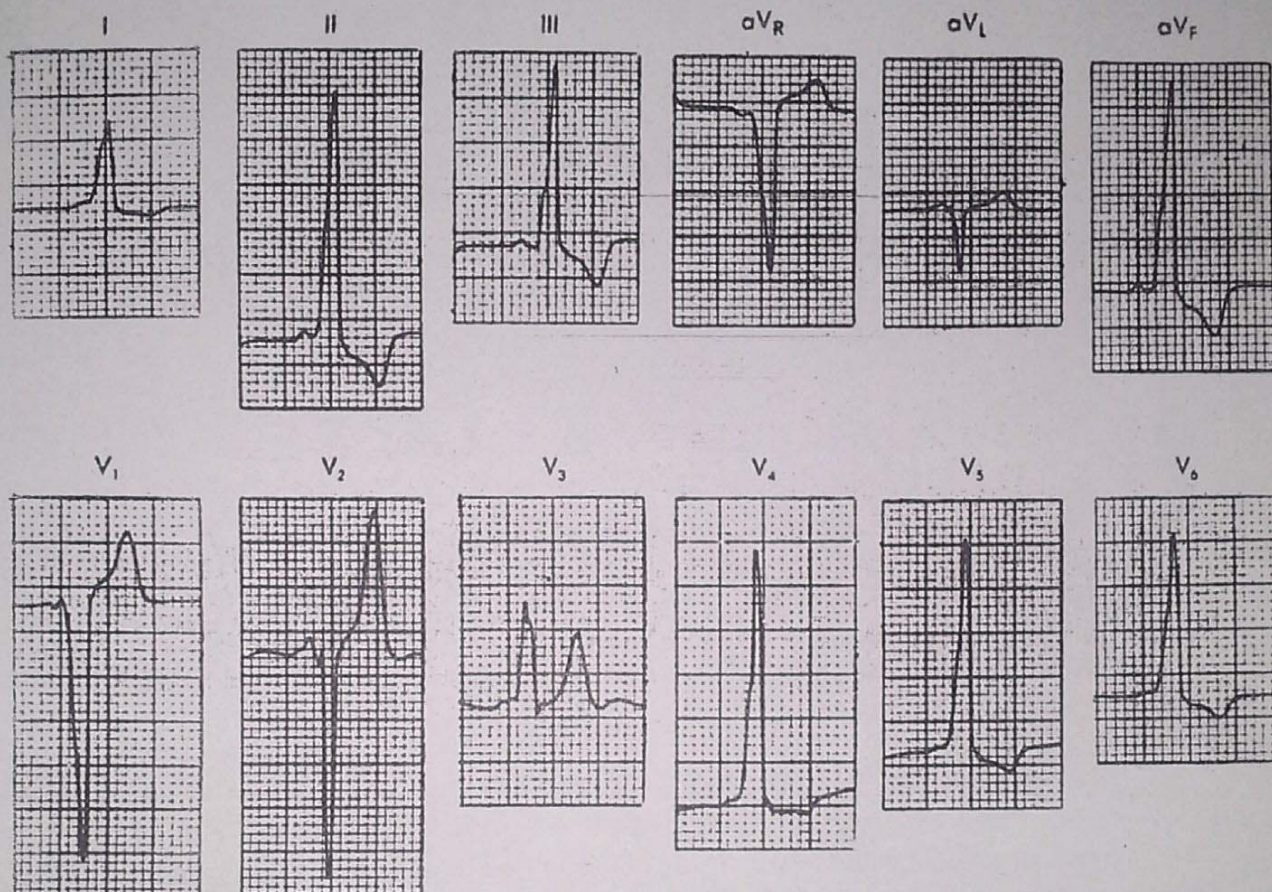
180. A 60-year-old man is admitted with severe congestive heart failure. His ECG is identical to one recorded 6 months earlier. Cardiac enzymes are normal. What is the likely diagnosis?



181. A 27-year-old man is told he has "congenital heart disease." Except for some mild exertional fatigue, he feels fine. He is not cyanotic on physical examination. A loud systolic ejection murmur is heard with fixed splitting of the second heart sound. What does his ECG show, and what is the likely clinical diagnosis?

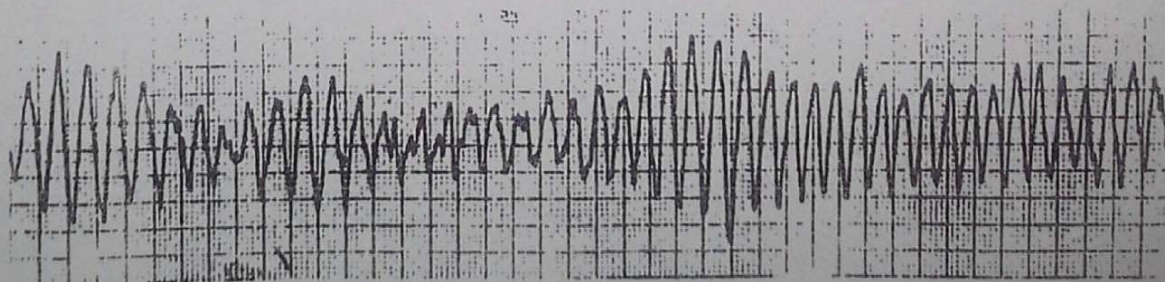


182. A 37-year-old man presents with intermittent palpitations. What does his ECG show?

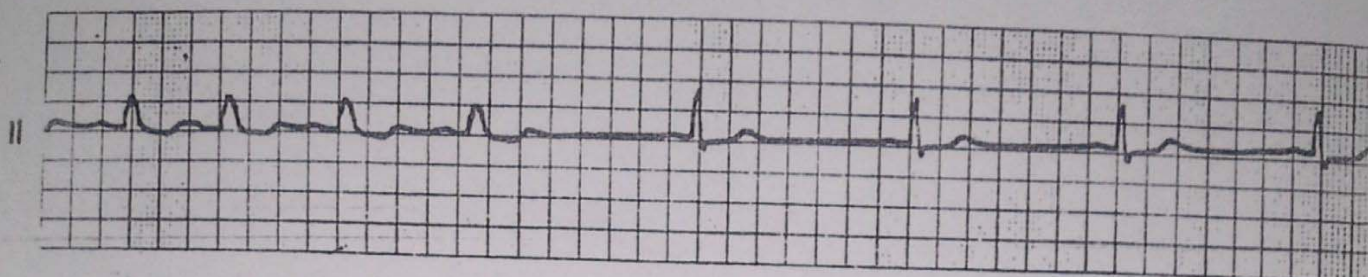


183. A 75-year-old woman treated with quinidine for atrial arrhythmias has a cardiac arrest 4 days later. This rhythm strip was obtained. What does it show?

MONITOR LEAD

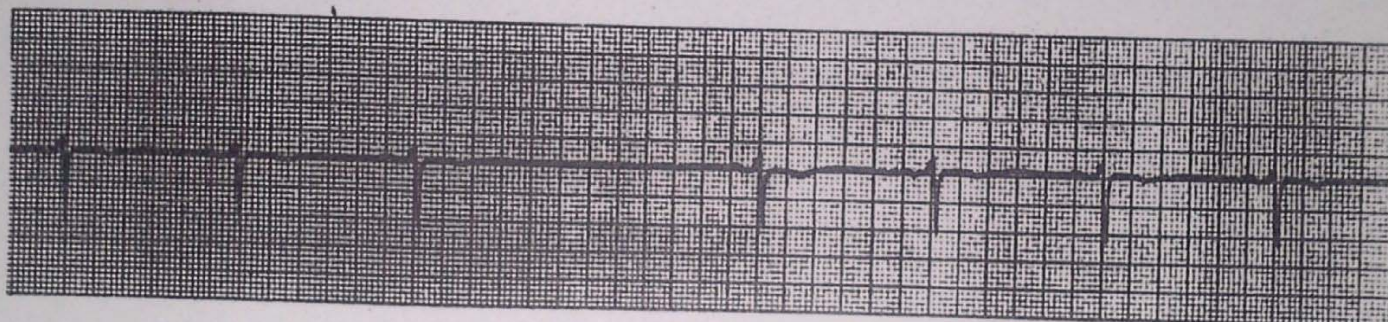


184. The ECG was initially misinterpreted as showing "accelerated idioventricular rhythm." What is the correct diagnosis?

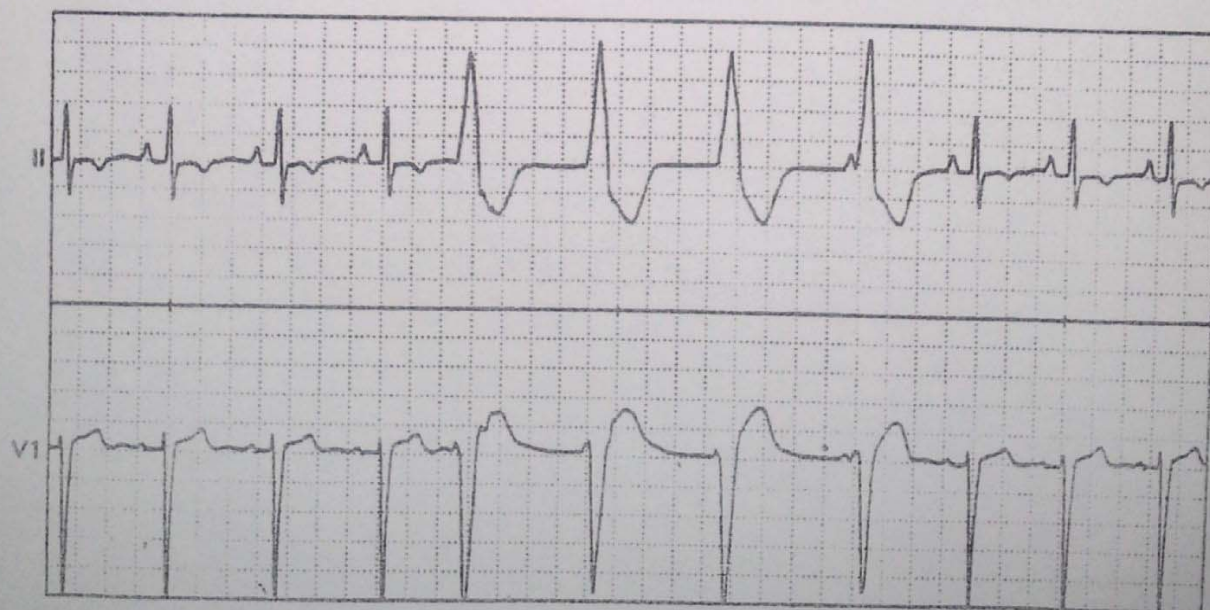


185. An 80-year-old woman complained of light-headedness. The following rhythm strip was obtained in the coronary care unit. What conduction disturbance is present?

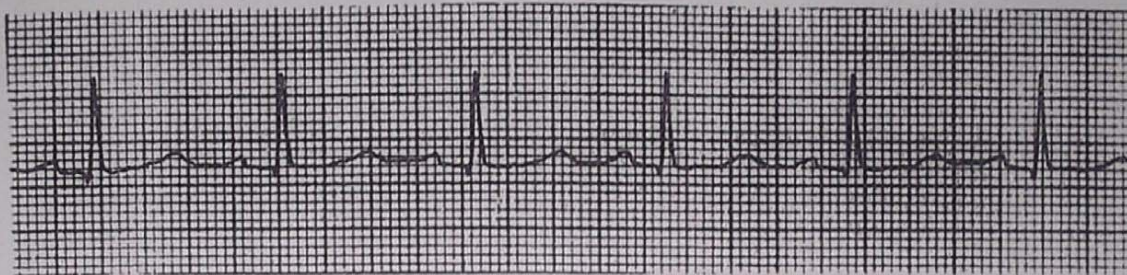
MONITOR LEAD



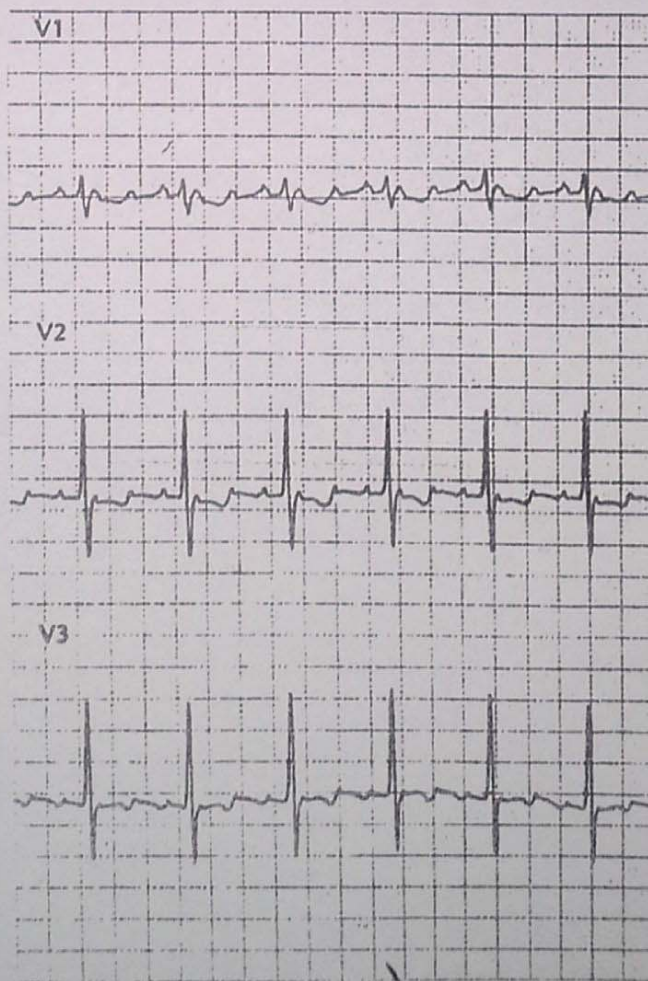
186. The following Holter monitor recording shows sinus rhythm with intermittent
- a. Ventricular tachycardia
 - b. Left bundle branch block
 - c. Accelerated idioventricular rhythm (AIVR)
 - d. Wolff-Parkinson-White pattern
 - e. Ventricular paced rhythm



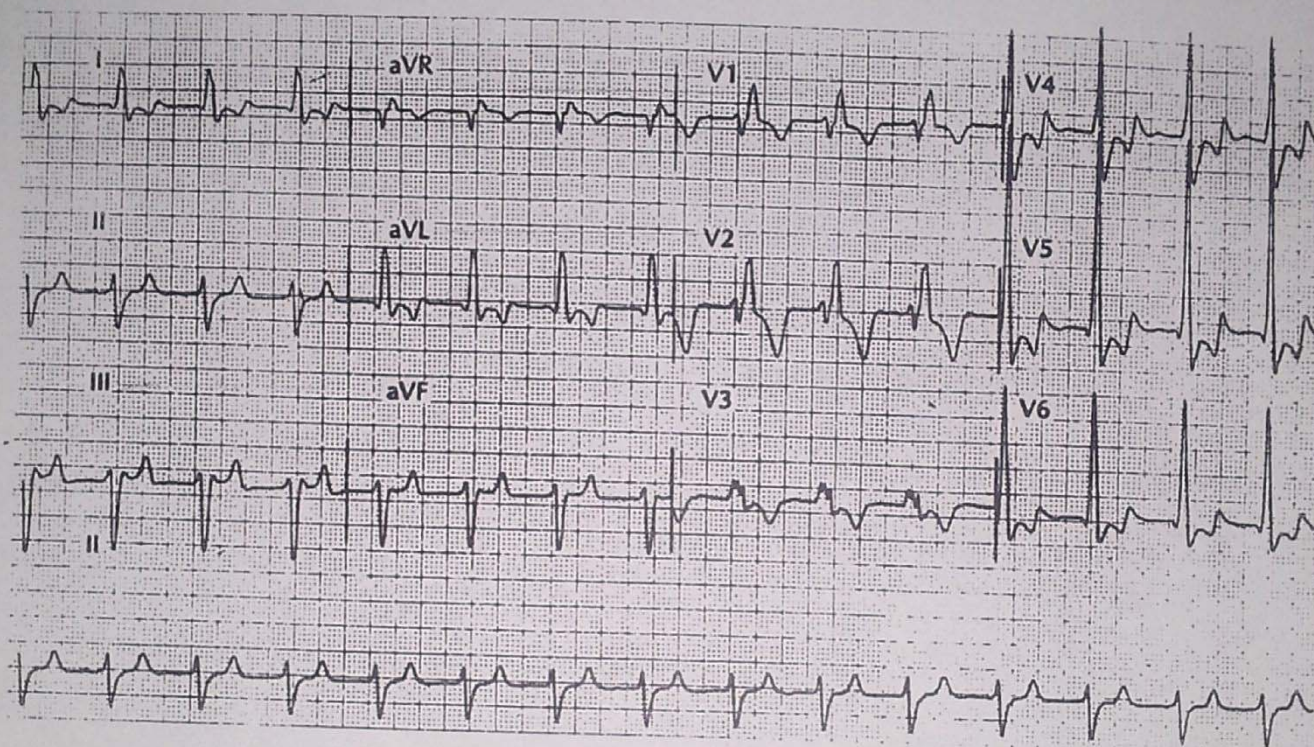
187. This ECG gives an important clue to a life-threatening electrolyte abnormality. (The serum K^+ was normal.) What is the likely diagnosis?



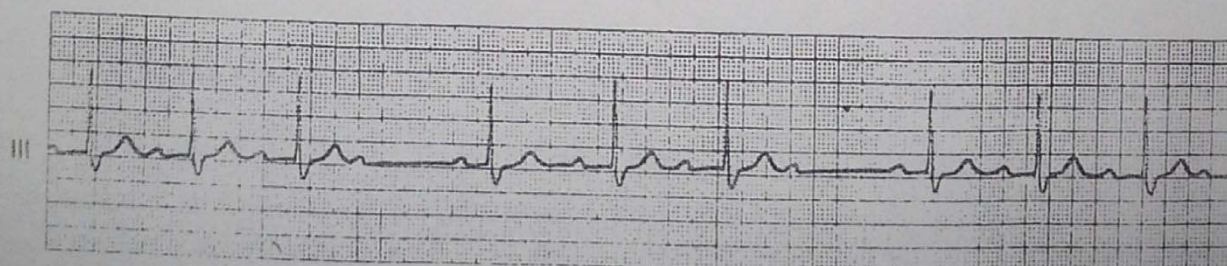
188. This ECG shows
- Sinus tachycardia
 - Atrial flutter with 3:1 conduction
 - Paroxysmal atrial tachycardia (PAT) with block
 - Multifocal atrial tachycardia
 - None of the above



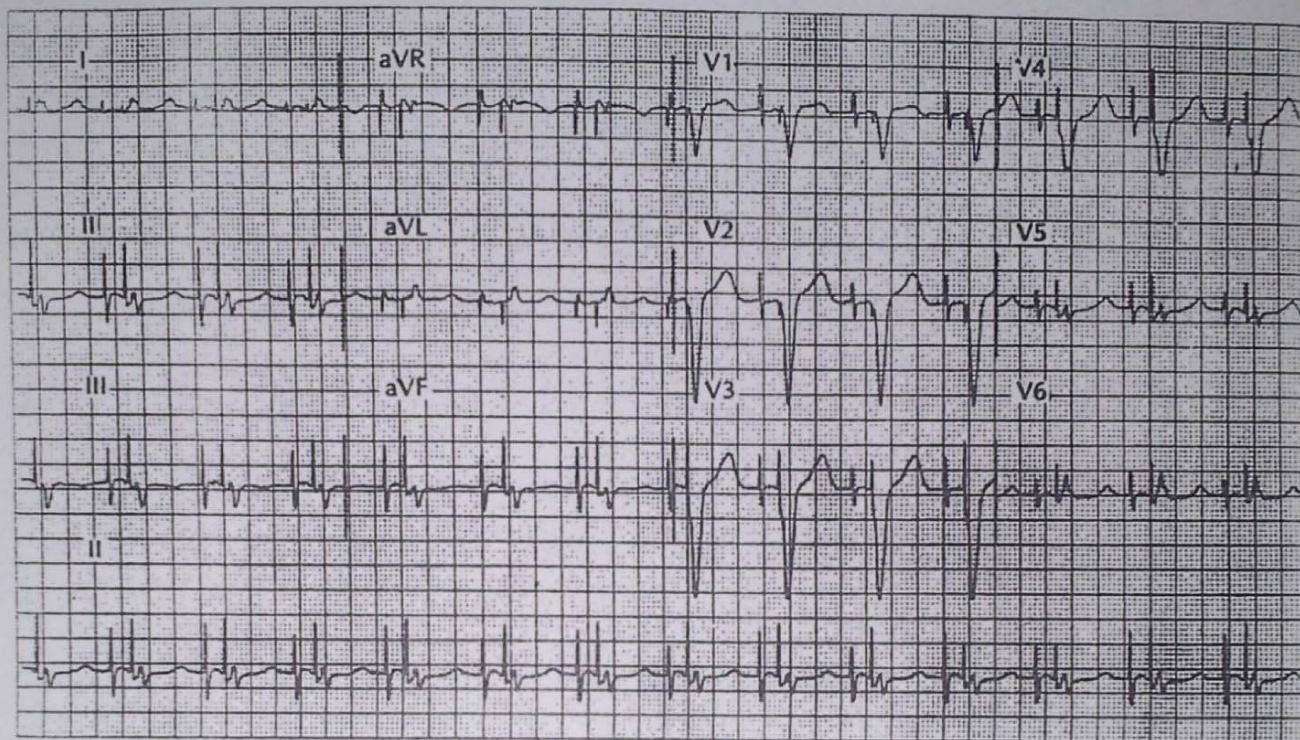
189. What life-threatening metabolic disturbance does this ECG most strongly suggest?
- Hyperkalemia
 - Hypokalemia
 - Hypercalcemia
 - Hypocalcemia
 - Hyponatremia



190. This patient was thought to have atrial fibrillation on examination. What is the actual finding accounting for the erratic pulse on this Holter monitor recording?

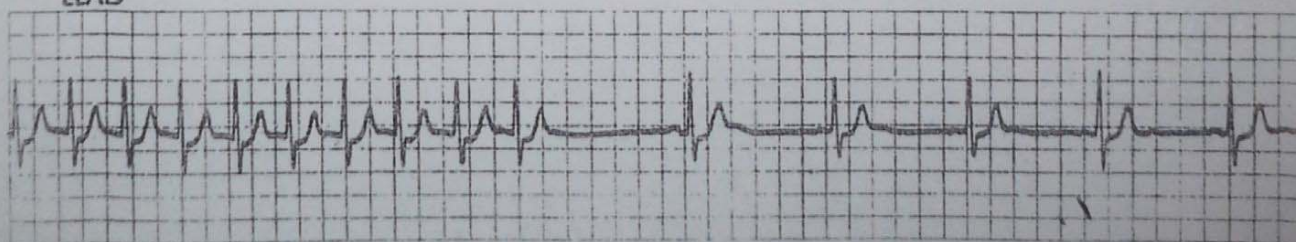


191. What does this patient have to account for this ECG pattern?

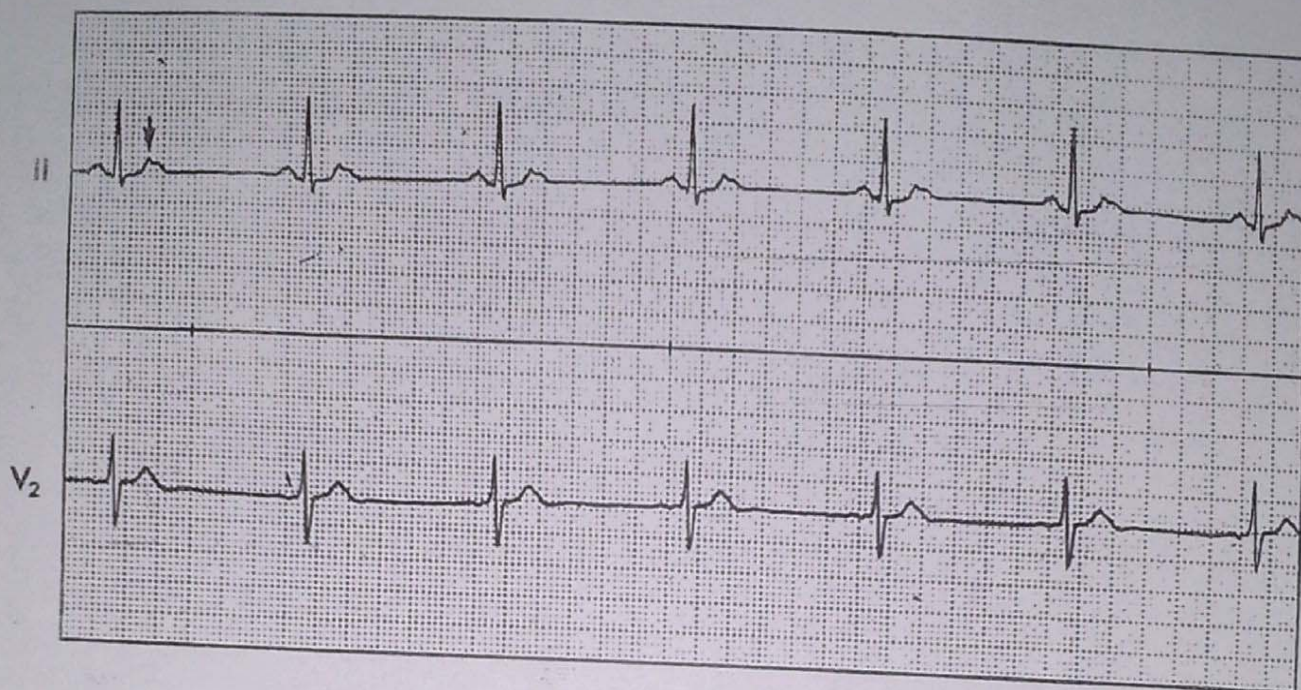


192. A 54-year-old woman complained of palpitations. The monitor lead recorded this episode. What is the diagnosis?

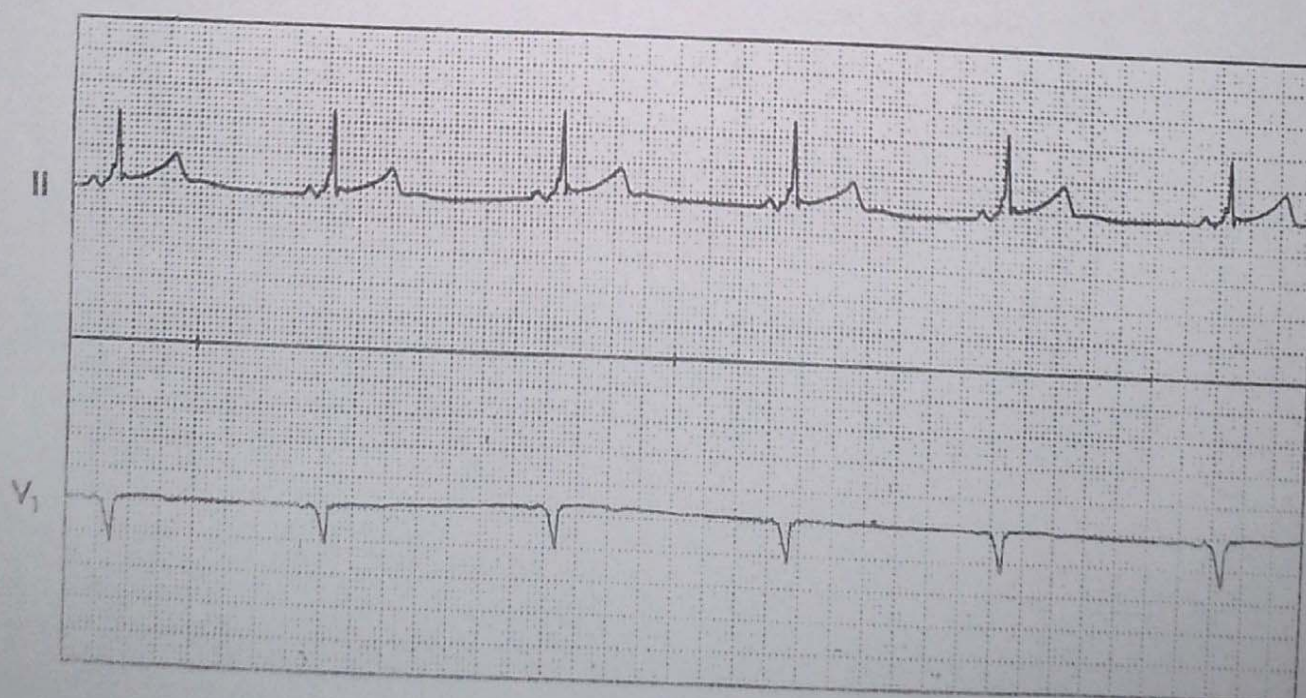
MONITOR
LEAD



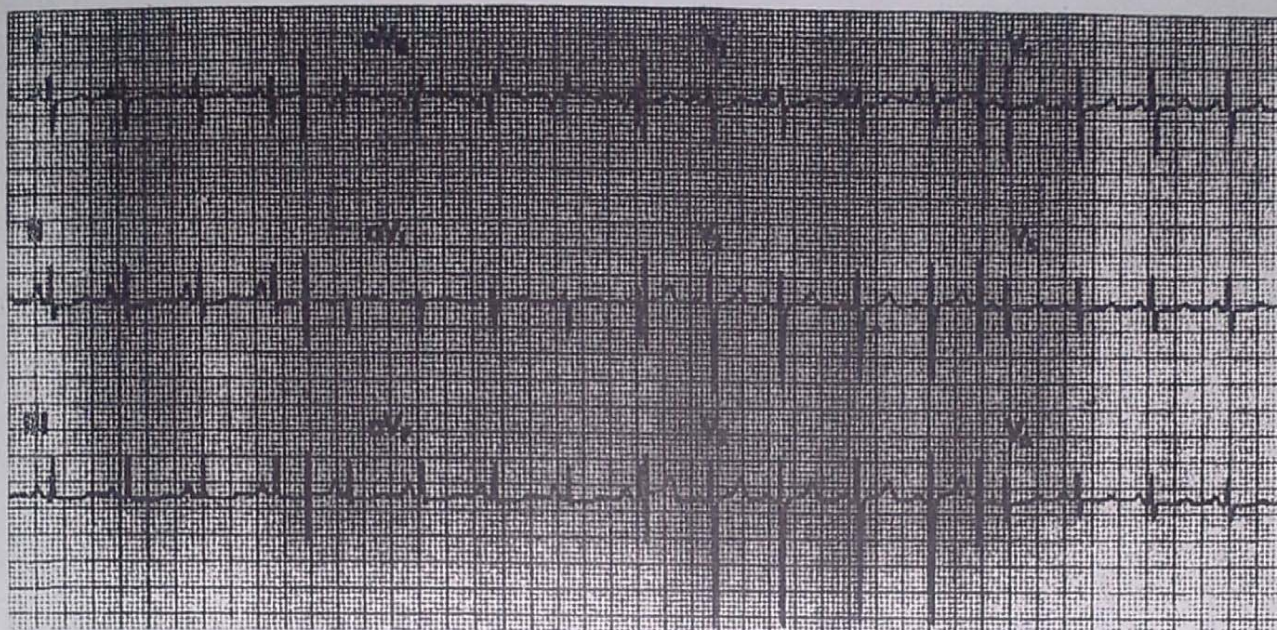
193. Two simultaneous leads were recorded during Holter monitoring of a patient with frequent APBs. What does the *arrow* point to? What is this arrhythmia?



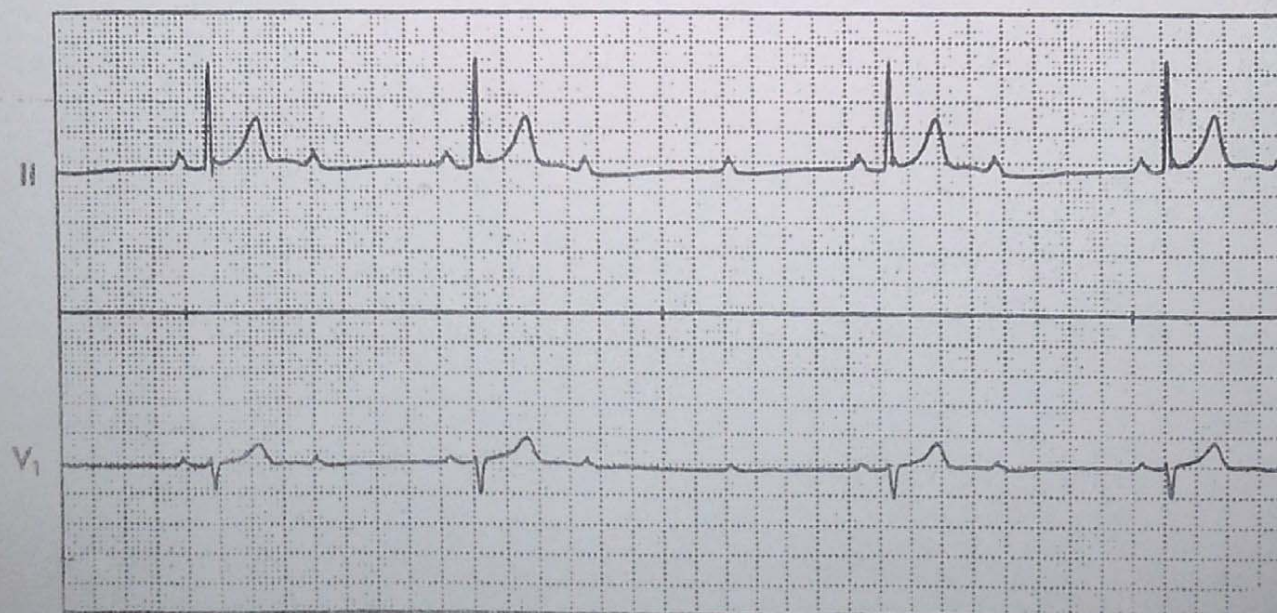
194. Two simultaneous leads were recorded during Holter monitoring. The rhythm is sinus bradycardia. What subtle conduction abnormality is present? What is the anatomic substrate for this finding?



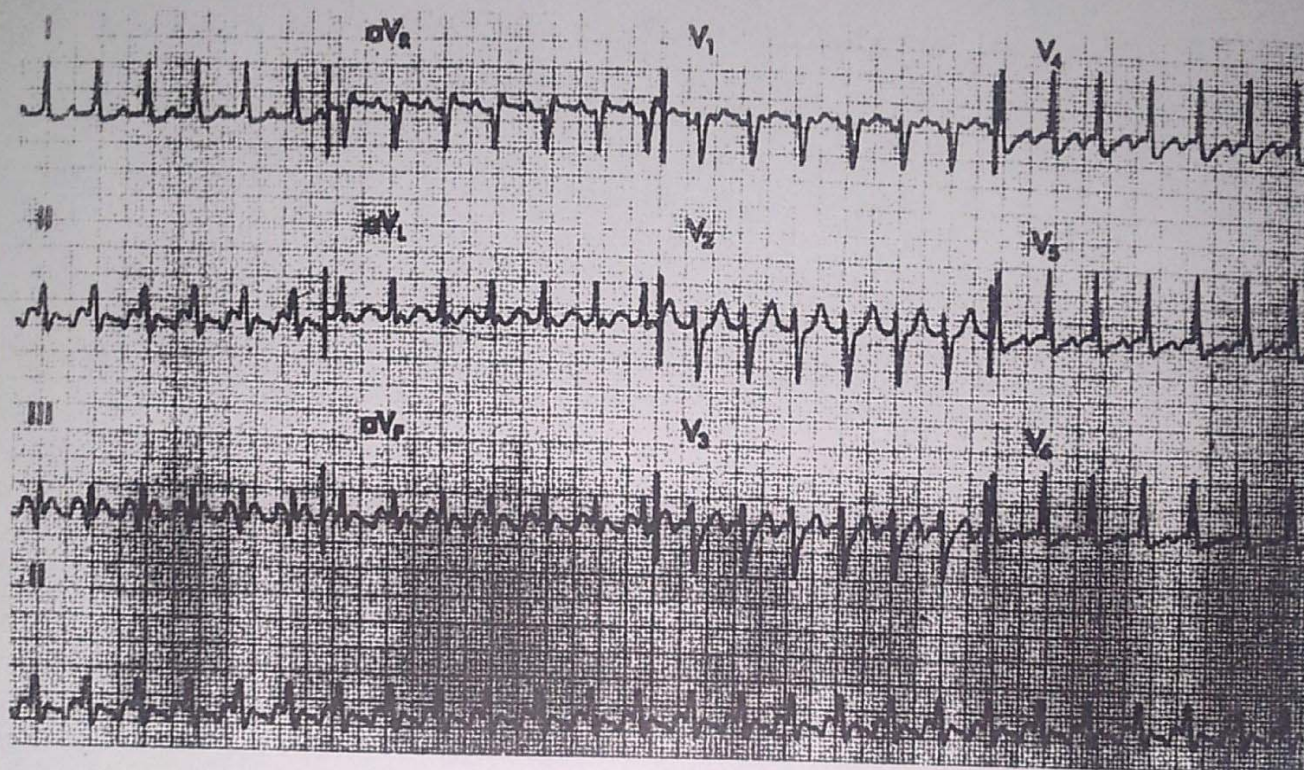
195. A 54-year-old woman presented with chronic obstructive pulmonary disease. Does the ECG fit in with this diagnosis?



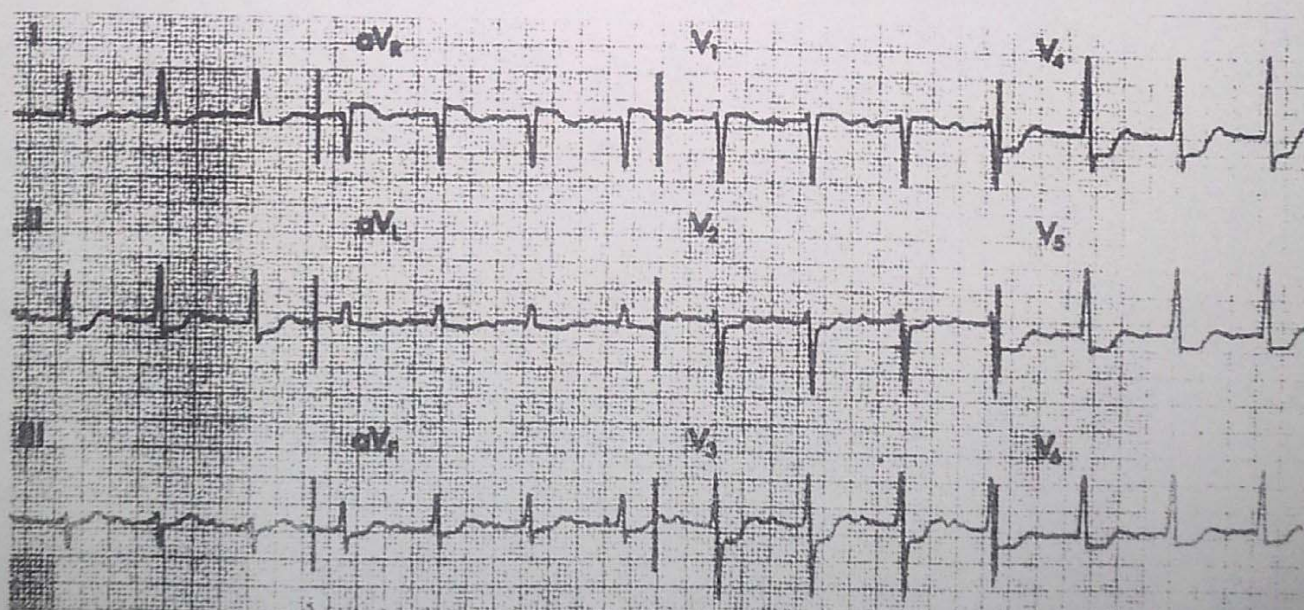
196. A Holter monitor recorded this strip from a patient complaining of intermittent lightheadedness. What arrhythmia is present?



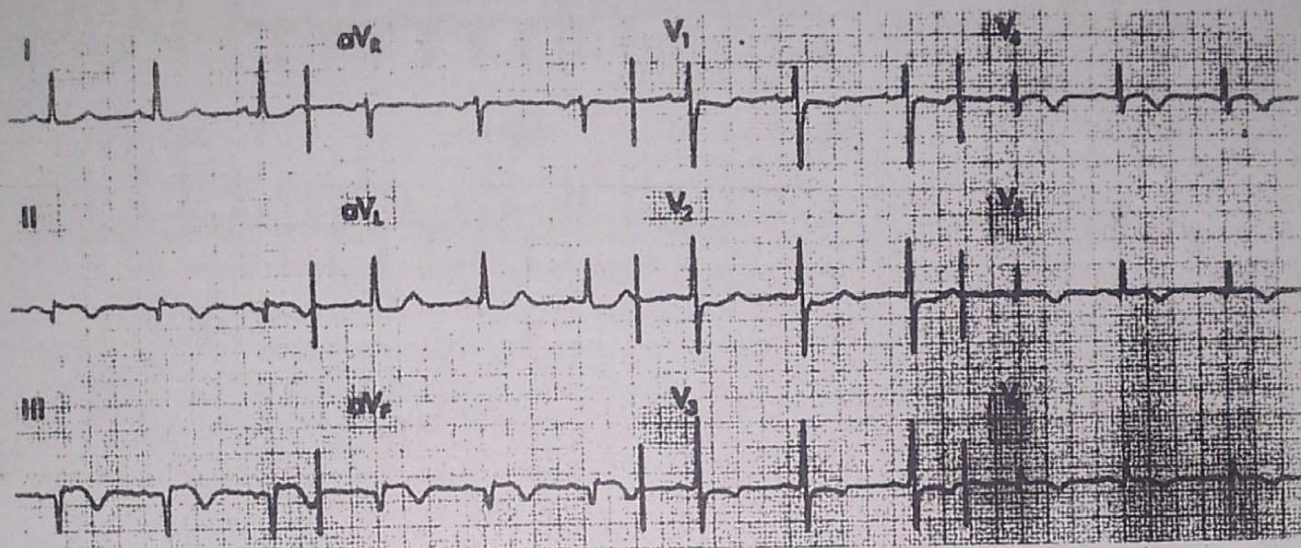
197. A 77-year-old woman complains of shortness of breath and palpitations. What is the rhythm?



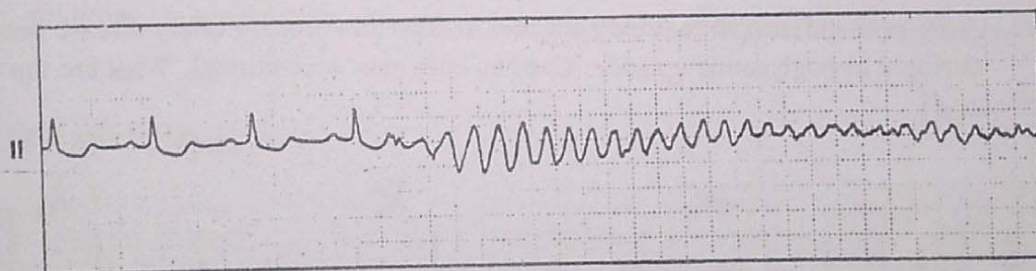
198. A 76-year-old insulin-requiring diabetic man with coronary artery disease became hypotensive during a hypoglycemic episode. Cardiac enzymes were normal. What are the major ECG findings?



199. A 65-year-old woman had chest pain 3 days earlier. What are the major findings?



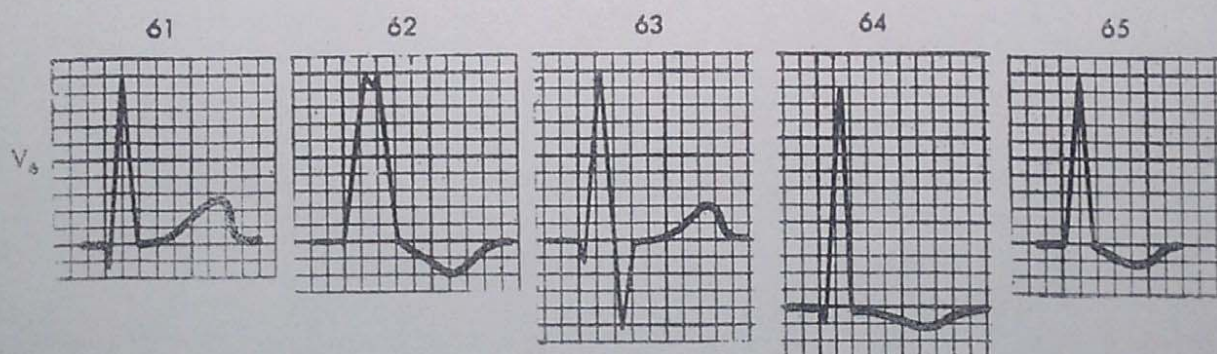
200. Finale.



ANSWERS

1. Atrial depolarization (stimulation).
2. Ventricular depolarization (stimulation).
3. Ventricular repolarization (recovery).
4. 0.12 and 0.2.
5. Fourth.
6. Lengthens.
7. Wolff-Parkinson-White syndrome.
8. Quinidine, procainamide, disopyramide, sotalol, amiodarone, and others
9. Pericardial effusion, emphysema, and obesity. Also extensive myocardial fibrosis or infiltration with substances like amyloid. Low voltage may also be a normal variant.
10. Ventricular ectopy (VPBs, ventricular bigeminy, ventricular tachycardia, ventricular fibrillation, bidirectional tachycardia), sinus bradycardia and SA block, junctional rhythms, PAT with block, and so on. (See page 204.)
11. RBBB.
12. Right axis shift, S_1Q_{III} pattern, RBBB, sinus tachycardia and other arrhythmias, right ventricular strain. (See page 135 for other patterns.)
13. +5 mm. Recall that the summed voltages of each of the waveforms in $aV_R + aV_L + aV_F$ must equal 0.
14. Hypokalemia and renal insufficiency; also hypoxia, hypercalcemia, hypomagnesemia, old age, and others. (See pages 204 and 206.)
15. Decreases.
16. Hyperkalemia, quinidine, procainamide, disopyramide, tricyclic antidepressants, phenothiazines, etc.
17. Hypokalemia.
18. P pulmonale (right atrial enlargement).
19. aV_R , II.
20. See page 48.
21. 1.
22. Hyperthyroidism.
23. Ventricular fibrillation (and related ventricular tachyarrhythmias), asystole (with or without escape beats), and electromechanical dissociation.
24. Fever, excitement, and congestive heart failure. (See page 150 for other causes.)
25. Stokes-Adams.
26. Three or more consecutive VPBs.
27. Hyperkalemia.
28. Acute myocardial infarction, acute pericarditis, Prinzmetal's angina; also ventricular aneurysm.
29. ST segment depressions.
30. False. Some normal people will have an RBBB pattern.

31. False. Atrial fibrillation, although often seen in people with organic heart disease (coronary, hypertensive, valvular, etc.), may occur in people with normal hearts. It may also be associated with metabolic factors (hyperthyroidism) or excessive alcohol consumption ("holiday heart syndrome").
32. True.
33. True. (See page 133.)
34. True.
35. Depressions (reciprocal to the ST elevations seen in the anterior leads).
36. Left atrial abnormality (enlargement).
37. See page 12.
38. LBBB.
39. Myocardial ischemia, digitalis toxicity, hypokalemia, hypoxia, pulmonary embolism, and congestive heart failure. (See page 183 for additional causes.)
40. Paroxysmal supraventricular tachycardia (PSVT), probably due to AV nodal reentry. See also Question 100.
41. Sinus bradycardia, AV junctional rhythm, AV heart block (second or third degree) or AV dissociation, atrial fibrillation or flutter with a slow ventricular response, or idioventricular escape rhythm.
42. -30° .
43. Normal variant, beta blockers such as propranolol, calcium channel blockers (verapamil, diltiazem), digitalis toxicity, increased vagal tone caused by myocardial ischemia, and so on.
44. Coronary artery disease, hypertensive heart disease, and mitral valve disease.
45. Ventricular aneurysm.
46. AV nodal reentrant tachycardia.
47. Left atrial abnormality (enlargement).
48. Digitalis.
49. 0.1 second.
50. V_6 .
- 51-60. See the pages listed.
- 61-65. See diagrams below.



66. Hyperkalemia. Notice the tall "tented" T waves. First degree AV block is also present.
67. Digitalis.
68. RBBB is present with wide rSR' complexes in V_1 . (In addition, first-degree AV block is present.)
69. Sinus rhythm with a brief nonsustained (five-beat) run of ventricular tachycardia.
70. Ventricular premature beat.
71. A. 0° .
B. $+180^\circ$.
In both A and B, lead aV_F shows a biphasic RS-type complex; thus the mean QRS axis must be directed at right angles to the axis of lead aV_F , which is at $+90^\circ$. In example A lead I shows a positive R wave deflection, so the axis must be pointed in that direction (at 0°). In example B the mean QRS axis is directed at right angles to aV_F , away from I, and toward leads III and aV_R , or at $+180^\circ$ (marked right axis deviation).
72. $+150^\circ$. Lead II shows a biphasic RS complex; thus the mean QRS axis must be directed at right angles to the axis of lead II, which is at $+60^\circ$. Therefore the axis must be either -30° or $+150^\circ$. Obviously, since I is negative and II and aV_R are mainly positive, the axis must be $+150^\circ$. This indicates marked right axis deviation.
73. Left.
74. a. The QT interval is prolonged (0.48 sec) with a sinus bradycardia at 55/min.
b. QT prolongation may be caused by numerous factors, including hypocalcemia (present here, note the long ST segment), hypokalemia (often with large U waves), and drugs such as quinidine or procainamide (with wide flattened T waves).
75. Atrial flutter. Notice the characteristic sawtooth flutter waves. The atrial (flutter) rate is approximately 300 beats/min, while the ventricular (QRS) rate is about 75 beats/min; thus 4:1 flutter is present.
76. a. About 70/min.
b. AV Wenckebach. Notice the repeating cycles in which the PR intervals get progressively longer until the P wave is not conducted. (The fifth and ninth P waves are not conducted.)
c. The wide notched P waves indicate left atrial abnormality (enlargement).
77. a. About 130 beats/min. (There are 13 QRS cycles/6 sec.) (See page 15.)
b. Atrial fibrillation. Often, as in this case, with rapid atrial fibrillation, the fibrillation waves are not well seen. The diagnosis of atrial fibrillation is then made by finding a haphazardly irregular rhythm with no discrete P waves.
78. First-degree AV block (PR interval about 0.22 sec). Notice that the QRS is somewhat wide, 0.11 second, indicating some type of intraventricular conduction disturbance as well.
79. A is an atrial premature beat (APB). B is a junctional escape beat.
80. a. Complete heart block. To analyze this arrhythmia, you need to label each P wave and each QRS complex. The ventricular rate is about 40 beats/min. Looking at the P waves (some of which are hidden by QRS complexes and T waves), you can see that the atrial rate is 90 to 100 beats/min and the PR intervals are completely variable. Therefore complete heart block is present. The QRS complexes are abnormally wide probably because the ventricles are being paced by an idioventricular focus located below the AV junction.
b. The patient complained of light-headedness and fainting spells (Stokes-Adams syndrome).

81. The first part of the rhythm strip shows *coarse atrial fibrillation*, which then spontaneously converts to a marked *sinus bradycardia*. This sequence suggests the *brady-tachy variant* of the *sick sinus syndrome*.
82. Atrial fibrillation with a rapid ventricular rate. This may be due to multiple conditions, including coronary artery disease, hypertension, valvular disease, cardiomyopathy, alcohol consumption, and hyperthyroidism.
83. RBBB.
84. Atrial paced rhythm. Notice the pacemaker spike before each P wave.
85. Atrial fibrillation.
86. Sinus arrhythmia.
87. Sinus rhythm with a multiform ventricular couplet.
88. Sinus tachycardia. (Nonspecific ST-T changes are also present.)
89. Ventricular fibrillation.
90. Ventricular tachycardia.
91. Atrial fibrillation.
92. Sinus rhythm with first-degree AV block.
93. Sinus rhythm with atrial premature beats. (The third, sixth, and ninth beats are APBs; therefore this is atrial *trigeminy*.)
94. Sinus rhythm with ventricular premature beats. (The second and sixth beats are VPBs.)
95. Sinus bradycardia. (Notice also the abnormal ST-T segment because of left ventricular strain or ischemia.)
96. AV junctional rhythm. (Notice the absence of visible P waves with a normal-duration QRS complex. AV junctional rhythms with rates between about 70 and 120 are sometimes referred to as nonparoxysmal AV junctional tachycardias or accelerated junctional rhythms.)
97. Sinus tachycardia with a short burst of ventricular tachycardia. (The ninth beat is also a VPB.)
98. Sinus rhythm with an APB (fourth beat).
99. Sinus rhythm with a run of accelerated idioventricular rhythm (AIVR). Notice that the second and ninth beats are *fusion* beats.
100. Paroxysmal supraventricular tachycardia (PSVT) at a rate of about 190/min. Given the absence of visible P waves (which are probably occurring during the QRS), this most likely represents AV nodal reentrant tachycardia.
101. Ventricular bigeminy.
102. Coarse atrial fibrillation with incomplete RBBB (note the rSR' in lead V₁).
103. Idioventricular (slow ventricular escape) rhythm.
104. Atrial flutter with variable block.
105. Ventricular trigeminy. Every second sinus beat is followed by a VPB.
106. Coarse atrial fibrillation.
107. Accelerated junctional rhythm (nonparoxysmal AV junctional tachycardia). Notice the absence of visible P waves. (See Question 96.)
108. Ventricular paced rhythm. Notice the pacemaker spike before each QRS and the nonconducted P waves (some hidden). The latter indicate underlying complete heart block.
109. Ventricular fibrillation (recorded during cardiac arrest).

110. Ventricular tachycardia.
111. Atrial flutter with 2:1 block (atrial rate, about 300 beats/min; ventricular rate, about 150 beats/min).
112. Lead II rhythm strip showing marked ST elevations (caused by acute inferior wall infarction) with a junctional (or ectopic atrial) rhythm. (Notice the retrograde P waves immediately preceding each QRS.)
113. Sinus rhythm with a three-beat run of paroxysmal atrial tachycardia (PAT). Notice that complexes 5 to 7 are atrial premature beats (APBs).
114. Atrial flutter with variable block; incomplete RBBB.
115. Pacemaker rhythm with pacemaker malfunction. Notice the pacemaker spike in the center of the strip, which is not followed by a QRS (owing to pacemaker failure).
116. LBBB.
117. a. *Analysis*

- (1) Standardization: 1 mV = 10 mm (mark as shown).
- (2) Heart rate: about 60 beats/min.
- (3) Rhythm: normal sinus.
- (4) PR interval: about 0.16 second (normal).
- (5) P wave size: broad and biphasic in V_1 , suggesting possible left atrial abnormality, although in other leads within normal limits.
- (6) QRS width: 0.1 second (upper limits of normal).
- (7) QT interval: about 0.4 second (normal for rate).
- (8) QRS voltage: R wave in aV_L is abnormally tall (15 mm).
- (9) Mean QRS axis: about -60° . The R wave in aV_L equals the S wave in aV_F , so the mean QRS axis must lie between the positive pole of aV_L (-30°) and the negative pole of aV_F (-90°). Therefore the mean QRS axis must be approximately -60° .
- (10) R wave progression in chest leads: poor, with QS complexes in V_1 to V_3 .
- (11) Abnormal Q waves: V_1 to V_3 show abnormal QS complexes. Notice the bizarre W-shaped QS in V_3 .
- (12) ST segment elevation in V_2 with slight depression in V_3 to V_6 .
- (13) T waves: inverted in I, aV_L , and V_4 to V_6 , with some scooping of the ST segment in I and aV_L .
- (14) U waves: normal.

b. *Interpretation*

Abnormal ECG. Left axis deviation consistent with left anterior hemiblock.

QS complexes in V_1 to V_3 consistent with anteroseptal infarction of indeterminate age.

Left ventricular hypertrophy by voltage.

Left atrial abnormality.

Abnormal ST-T changes consistent with left ventricular strain and/or ischemia, and possibly with digitalis effect (with scooping of ST-T in I and aV_L). (The ST-T changes on this ECG are somewhat complicated. As noted, the T wave inversions and slight ST depressions in V_3 to V_6 may reflect a combination of left ventricular strain and/or lateral wall ischemia. The scooping of the ST-T segment in I and aV_L may also reflect strain or

ischemia but is suggestive of the classic pattern of digitalis effect as well. Finally, notice the high takeoff of the ST segment in V_2 , suggesting acute infarction. However, in cases of LVH the right precordial leads may show such ST elevation as a persistent finding in the absence of acute ischemia.)

118. a. *Analysis*

- (1) Standardization: $1 \text{ mV} = 10 \text{ mm}$ (mark not shown).
- (2) Heart rate: approximately 40 beats/min.
- (3) Rhythm: sinus bradycardia.
- (4) PR interval: about 0.18 second.
- (5) P wave size: biphasic in V_1 , suggesting possible left atrial abnormality.
- (6) QRS width: 0.1 to 0.11 second.
- (7) QT interval: 0.52 second (within normal limits for rate).
- (8) QRS voltage: tall in chest leads ($S_{V_1} + R_{V_6} = \text{more than } 35 \text{ mm}$).
- (9) Mean QRS axis: about $+30^\circ$. R waves are of equal amplitude in I and II so the mean QRS axis must be directed between these leads.
- (10) R wave progression in chest leads: delayed, with the transition zone between V_4 and V_5 .
- (11) Abnormal Q waves: none.
- (12) ST segments: isoelectric.
- (13) T waves: inverted in I, II, aV_L , V_5 , and V_6 .
- (14) U waves: small in V_1 to V_4 .

b. *Interpretation*

Abnormal ECG.

Marked sinus bradycardia.

Left ventricular hypertrophy by voltage. ST-T changes are consistent with left ventricular "strain" and possibly ischemia.

Possible left atrial abnormality.

In this case the left ventricular hypertrophy and atrial abnormality resulted from hypertensive heart disease. The marked sinus bradycardia was caused by one of the drugs (beta blocker) that the patient was taking for high blood pressure.

119. a. *Analysis*

- (1) Standardization: $1 \text{ mV} = 10 \text{ mm}$ (mark not shown).
- (2) Heart rate: approximately 75 beats/min.
- (3) Rhythm: ectopic atrial. (Notice the retrograde P waves in II with biphasic P waves in aV_R .)
- (4) PR interval: 0.1 (short because of the ectopic atrial rhythm).
- (5) P wave size: normal.
- (6) QRS width: 0.08 second.
- (7) QT interval: 0.35 second (normal for rate).
- (8) QRS voltage: tall in aV_L (R wave = 16 mm).
- (9) QRS axis: approximately -45° . The R wave in I is about equal to the S wave in aV_F . Therefore the mean QRS axis must lie midway between the positive pole of I (0°) and the negative pole of aV_F (-90°), making the axis -45° . Furthermore, by inspection, you can tell that left axis deviation is present (axis more negative than -30°), since

lead II shows an rS complex with the S wave deeper than the r wave is tall. (See page 55.)

- (10) R wave progression in the chest leads: delayed with QS complexes in V_1 to V_3 .
- (11) Abnormal Q waves: QS complexes in leads V_1 to V_3 . Abnormally wide in aV_L . (Notice that this Q wave is 0.04 second wide, making it abnormal even though it is not very deep.)
- (12) ST segments: slightly elevated in V_2 to V_4 .
- (13) T waves: deeply inverted and symmetric in I, II, aV_L , and V_2 to V_6 .
- (14) U waves: normal.

b. *Interpretation*

Abnormal ECG.

Ectopic atrial rhythm.

LVH by voltage.

Left axis deviation consistent with left anterior hemiblock.

Abnormal Q waves and T wave inversions consistent with anterior wall infarction (possibly recent or evolving).

The exact age of the infarct cannot be deduced from the ECG. In this case it was 1 week old.

120. a. *Analysis*

- (1) Standardization: 1 mV = 10 mm (mark shown in V_1).
- (2) Heart rate: approximately 75 beats/min, with slight irregularity.
- (3) Rhythm: normal sinus, with both premature atrial beats (in I, aV_F , V_2 , and V_6) and premature ventricular beats (third beat in V_1).
- (4) PR interval: 0.12 second (lower limits of normal).
- (5) P wave size: broad and biphasic in V_1 (suggesting left atrial abnormality).
- (6) QRS width: 0.12 to 0.13 second. The RSR' in V_1 indicates RBBB.
- (7) QT interval: 0.36 second (normal for rate).
- (8) QRS voltage: normal.
- (9) Mean QRS axis: $+90^\circ$. Biphasic RS wave in I.
- (10) R wave progression in chest leads: normal.
- (11) Abnormal Q waves in II, III, and aV_F .
- (12) ST segments: normal.
- (13) T waves: slight inversion in II, III, and aV_F .
- (14) U waves: normal.

b. *Interpretation*

Abnormal ECG.

Sinus rhythm with atrial and ventricular ectopy.

RBBB.

Left atrial abnormality.

Inferior wall infarct of indeterminate age.

121. a. *Analysis*

- (1) Standardization: 1 mV = 10 mm (mark not shown).
- (2) Heart rate: 55 to 60 beats/min.
- (3) Rhythm: sinus bradycardia.
- (4) PR interval: 0.16 second.
- (5) P wave size: normal.
- (6) QRS width: 0.08 second.
- (7) QT interval: 0.4 second (normal for rate).
- (8) QRS voltage: upper normal limits.
- (9) QRS axis: +30°.
- (10) R wave progression in chest leads: normal.
- (11) Abnormal Q waves: none.
- (12) ST segments: isoelectric in the extremity leads; slightly elevated J point in V₂ and V₃.
- (13) T waves: normal.
- (14) U waves: normal.

b. *Interpretation*

Normal electrocardiogram. The ST elevation in the chest leads represents a normal "early repolarization" variant. (The subject was a healthy 25-year-old man.)

122. Major findings are ST elevations and hyperacute T waves in the anterior chest leads (V₁ to V₅) with reciprocal ST depressions in II, III, and aV_F. (This patient was having an acute anterior wall infarction.)

123. c.

124. a. Yes. (Notice that the standardization mark in I is 10 mm tall.)

b. 60 beats/min.

c. Yes.

d. +30°.

e. No.

f. Yes.

g. Ischemic T wave inversions in I, aV_L, and V₂ to V₆. (Clinically the patient had an evolving non-Q wave MI.)

125. a. 60 beats/min.

b. Prominent Q waves in II, III, and aV_F with ST segment elevations in those leads and reciprocal ST depressions in I, aV_L, and V₂ to V₃; deep T wave inversions in II, III, aV_F, and V₄ to V₆. (This pattern is consistent with an evolving inferolateral infarct.)

126. c.

127. d.

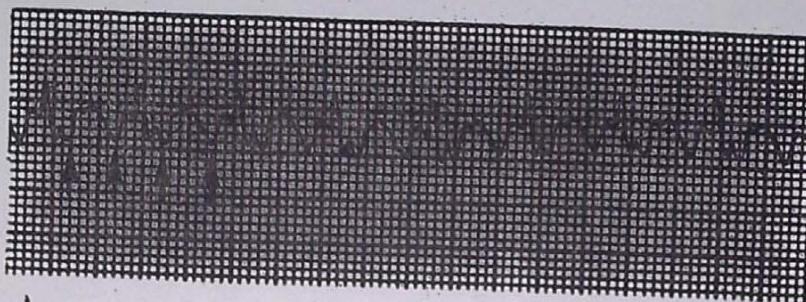
128. a. Prominent U waves.

b. The two major causes are hypokalemia and drug effect (particularly, quinidine, procainamide, and disopyramide). This patient was hypokalemic. Patients who have markedly prolonged repolarization with large U waves from any cause are at risk of developing torsade de pointes (p. 188).

129. Acute inferior wall and right ventricular infarction. Note the ST elevations and Q waves in II, III, and aV_F as well as the ST elevations in the right precordial leads. ST depressions in I and aV_L are consistent with reciprocal changes.
130. This is a normal "septal" q wave, representing left-to-right spread of septal depolarization forces. (Notice its low amplitude and short duration [less than 0.04 second].)
131. Subendocardial infarction. (Notice the diffuse marked ST depressions [I, II, III, aV_F , and V_3 to V_6] with ST elevation in aV_R . These changes indicate subendocardial ischemia or non-Q wave infarction. The elevated enzymes confirm infarction.)
132. Atrial flutter with 2:1 AV conduction. (The atrial rate is about 300/min, and the ventricular rate about 150/min. Notice the positive flutter waves in V_1 and the negative flutter waves in II. The classic sawtooth configuration may not be seen in all leads [e.g., V_1 here]. Low voltage in the limb leads is also present.)
133. Atrial bigeminy.
134. This shows abnormal T wave inversions in aV_L and V_3 to V_5 , suggesting myocardial ischemia, with or without actual infarction.
135. Paroxysmal supraventricular tachycardia (PSVT) converting abruptly to normal sinus rhythm. (Notice the sudden slowing of heart rate and the appearance of normal P waves.)
136. Acute anterior wall MI. (Pathologic Q waves in V_1 to V_5 and aV_L , with ST segment elevations in these leads and reciprocal ST depressions in II, III, and aV_F .)
137.
 - a. Left atrial abnormality (enlargement).
 - b. First-degree AV block (PR = 0.24 sec).
 - c. One VPB. In addition, there is axis deviation. (Notice the RS complex in II with the S wave > R wave. Therefore the axis must be more negative than -30° or more positive than $+150^\circ$. You need two frontal plane leads to know if the axis is markedly leftward or rightward.)
138. Prior anterior wall MI. (There is a loss of normal R wave progression, with pathologic Q waves in V_2 to V_5 .)
139.
 - a. RBBB.
 - b. Borderline first-degree AV block. (The PR is about 0.2 second.)
 - c. Nonspecific ST-T abnormalities. With "pure" RBBB you would expect to see T wave inversions in leads with an rSR' complex, so-called *secondary* ST-T changes. However, the ST segments here are also abnormally depressed in I, II, aV_F , and V_3 to V_6 . These *primary* ST-T changes are nonspecific and could have been caused by ischemia, digitalis effect, or some other condition. (See page 74.)
140. Paroxysmal atrial tachycardia (PAT) with 2:1 block. Notice the two P waves for every QRS, with an atrial rate of about 190/min and a ventricular rate of 95/min. This arrhythmia was due to digitalis toxicity.
141. Diffuse subendocardial ischemia. (Notice the horizontal or downward sloping ST segment depression, best seen in I, II, aV_F , and V_3 to V_6 , with ST elevation only in aV_R .)
142. Isorhythmic AV dissociation. (The atrial and ventricular rates are about equal, with P waves moving "in" and "out" of the QRS.) (See page 198.)
143. Sinus tachycardia with atrial quadrigeminy (i.e., every fourth beat an APB).

144. a. Prior inferior and anterolateral MIs, with Q waves in II, III, aV_F, V₅, and V₆ as well as T wave inversions in the left chest leads.
b. Borderline first-degree AV block (PR about 0.2 sec).
c. QT prolongation. (The interval is 0.4 second, which is somewhat long for a heart rate of about 77 beats/min. The patient was taking quinidine, a drug that may prolong the QT.)
d. Marked left axis deviation.
145. a. Evolving anterior wall MI with Q waves in V₁ to V₃ and deep T wave inversions in V₃ and V₄. (The ST-T changes in the inferolateral leads are also suggestive of ischemia.)
b. First-degree AV block.
c. Probable left atrial abnormality (enlargement) with broad P waves.
146. Complete heart block. Notice the independent atrial and ventricular complexes, with an atrial rate of about 100/min and a ventricular rate of about 40/min.
147. Sinus rhythm with AV Wenckebach. Notice the increased length of the PR interval preceding the nonconducted P wave. The PR interval *following* this P wave is shorter than the one preceding.
148. Sinus bradycardia (a common finding in athletes). Within normal limits.
149. Prior anteroseptal infarction. Abnormal Q waves in V₁ to V₃.
150. Complete heart block. (Notice the independent atrial and ventricular complexes, with the ventricles being paced by a slow idioventricular pacemaker [wide QRS]. The combination of heart block and syncope is called Stokes-Adams syndrome.)
151. LVH with associated ST-T abnormalities. (Notice the prominent chest lead voltage [S_{V₁} and R_{V₁}, greater than 35 mm] with "strain" pattern. P waves are prominent, broad, and notched in III [consistent with left atrial abnormality]. Notice also the relatively tall P waves in II. This combination may be due to biatrial enlargement. Notice that the patient also has sinus tachycardia, which can cause slightly peaked P waves without actual right atrial overload.)
152. Ventricular tachycardia (rapid, monomorphic).
153. Normal variant "early repolarization." (Notice the ST segment elevations [without reciprocal ST depressions] in V₂ to V₄.)
154. Wolff-Parkinson-White pattern. (Notice the triad of wide QRS, short PR interval, and slurring on the QRS upstroke [delta wave].)
155. a. Acute pericarditis. (Notice the ST elevations in I, II, III, aV_F, and V₄ to V₆, with T wave inversions in most of these leads. Diffuse distribution of ST elevations [present in I, II, and III] supports the clinical diagnosis of pericarditis. Notice also the LVH by voltage with left atrial abnormality. The patient was hypertensive as a result of chronic renal disease and had uremic pericarditis.)
156. Multifocal atrial tachycardia (MAT), which is most commonly associated with chronic obstructive lung disease.
157. a. Inferior wall MI of indeterminate age with Q waves in II, III, and aV_F and T wave inversions.
b. Anterior wall MI of indeterminate age with loss of R waves in V₁ to V₃ and Q waves in V₃ to V₅, as well as deep ischemic T wave inversions in I, aV_L, and V₂ to V₆.
c. LVH. (Notice the very prominent precordial voltage, with V₄ to V₆ recorded at one-half standardization.)

158. Paroxysmal atrial tachycardia (PAT) with 2:1 AV block. Notice the P waves sitting on the T waves. (This arrhythmia is often, but not always, associated with digitalis toxicity.)
159. a. Prior inferior wall MI.
b. Probable left atrial abnormality.
c. Nonspecific ST-T changes in V_4 to V_6 (consistent with ischemia or other causes).
160. Atrial flutter with 2:1 conduction (block). Flutter waves at a rate of about 300/min (arrows).



161. a. First-degree AV block.
b. Right axis deviation. (Notice that the R wave in III is greater than in II.)
c. Right ventricular hypertrophy with strain (with a tall R wave in V_1 and T wave inversions in the right chest leads.)
162. AV junctional rhythm (retrograde P waves following the QRS).
163. Acute pericarditis. (Notice the diffuse ST elevations in I, II, aV_F , and V_4 to V_6 . This pattern differs from the ST elevations of acute MI, which usually are more localized [anterior or inferior] with reciprocal changes. The pattern also differs from that of normal-variant "early repolarization" [Fig. 10-14], which does not usually produce such marked ST elevations in V_5 and V_6 as are seen here. With normal-variant early repolarization, the ST elevations are usually most prominent in V_3 and V_4 . Notice also the subtle PR changes [Fig. 10-11].)
164. Sinus tachycardia and P pulmonale (right atrial enlargement).
165. Atrial flutter with variable block.
166. b. Hyperkalemia. (There is widening of the QRS with peaking of the T waves and loss of the P waves [junctional rhythm].)
167. Severe hyperkalemia. The serum potassium was markedly elevated (8.1 mEq/L), and the ECG showed tall peaked T waves. (ST elevations in V_1 and V_2 may also be seen in this setting.) By the next day the serum potassium was normal (4.4 mEq/L).
168. Sinus rhythm with frequent multifocal atrial premature beats (APBs) at the end of the strip. This type of rhythm may lead to sustained multifocal atrial tachycardia (MAT) or atrial fibrillation.
169. Left bundle branch block.
170. Wandering atrial pacemaker. (Notice the subtle change in P waves.)
171. Accelerated idioventricular rhythm (AIVR).
172. The ST-T changes ("scooping") are consistent with digitalis effect, and the rhythm is atrial bigeminy.

173. Sinus rhythm with 2:1 AV block. Because the QRS is of normal duration here, this arrhythmia probably represents a Mobitz type I (Wenckebach) block and not a Mobitz type II block, which is often associated with a wide QRS. (See page 193.)
174. Sinus rhythm with AV Wenckebach. Nonconducted P waves are present on the T wave of the third and eighth QRS-T complexes. AV Wenckebach may be caused by a variety of factors, including drug toxicity (for example, digitalis, beta blockers, and, in this case, verapamil).
175. Evolving pattern of anterior wall infarction and right bundle branch block. Left atrial abnormality is also seen (V_1).
176. Atrial flutter with spontaneous conversion to sinus rhythm. Initially there is atrial flutter with 2:1 conduction. The degree of block increases just before conversion.
177. Atrial fibrillation may lead to left atrial thrombus formation and eventual embolization. An embolic-type cerebrovascular accident is therefore suggested. (Notice that with atrial fibrillation, fibrillatory waves may be hard to detect. The subtle changes in QRS complexes here from one beat to the next may reflect variability in ventricular conduction due to the fast rate.)
178. Complete heart block. Notice the independence of atrial (sinus) P wave activity (with a rate of about 90/min) and ventricular (QRS) complexes (at a rate of about 30/min). The combination of high-degree heart block and syncope is sometimes referred to as the Stokes-Adams syndrome. (This patient was treated with a permanent pacemaker.)
179. Paroxysmal atrial fibrillation.
180. Sinus rhythm, left axis deviation, and an intraventricular conduction delay (QRS duration = 0.12 sec). The major abnormality is extensive anterior wall infarction with pathologic Q waves in aV_L and V_1 to V_6 . In addition, the ST segments are elevated in these leads. Persistent ST elevations following infarction suggest a *ventricular aneurysm*, which was the cause of the patient's heart failure in this case.
181. The ECG shows right bundle branch block and right axis deviation. This pattern, given the patient's history and physical examination findings, is most suggestive of an atrial septal defect (p. 233).
182. Wolff-Parkinson-White (WPW) pattern. The triad of short PR interval, wide QRS, and slurring of the QRS upstroke (delta wave) is best seen in II, III, aV_F , and V_4 to V_6 . WPW is often associated with supraventricular tachycardias (in particular, a type of reentrant PSVT), which may have been the source of this patient's chief complaint of palpitations.
183. The classic pattern of *torsade de pointes*, a form of ventricular tachycardia characterized by oscillations in QRS amplitude and axis in the same lead. This potentially fatal arrhythmia is usually seen in the setting of abnormally prolonged ventricular repolarization, evidenced by long QT_c intervals or prominent U waves. Drugs such as quinidine may cause the arrhythmia (quinidine syncope). (See page 188 for other causes.)
184. Intermittent left bundle branch block. The first four beats are conducted with a left bundle branch block pattern, the last four with a normal QRS. In this case the bundle branch block was *rate related*. When the heart rate exceeded a critical value, the bundle branch block appeared. (Notice that all the beats are preceded by a P wave with a constant PR interval. Therefore this could *not* be accelerated idioventricular rhythm.)
185. There is underlying sinus bradycardia with a 2.4-second pause following the third beat. This pause is almost exactly twice the underlying PP interval. Therefore the patient probably has

2:1 SA block. Unlike 2:1 AV block (in which a P wave is not followed by a QRS), 2:1 SA block causes an entire P-QRS-T cycle to be "dropped." This patient had "sick sinus syndrome" and required a permanent pacemaker.

186. c.
187. Long QT (about 0.53 second) at a heart rate of 70/min. The patient had severe hypocalcemia.
188. b. The atrial rate is about 300/min, which is diagnostic of flutter.
189. e. Notice the wide QRS complexes with absent P waves.
190. Sinus rhythm with AV Wenckebach.
191. A dual-chamber pacemaker. Notice the repeating sequence of atrial pacemaker spike, P wave, ventricular pacemaker spike, and wide QRS.
192. The first part of the rhythm strip shows a run of paroxysmal supraventricular tachycardia (PSVT), probably due to AV nodal reentry given the absence of visible P waves. The tachyarrhythmia spontaneously breaks with the resumption of sinus bradycardia, raising the question of a brady-tachy variant of the "sick sinus syndrome."
193. The arrow points to a nonconducted (blocked) atrial premature beat (blocked APB). In fact, each normal beat here is followed by a subtle blocked APB; therefore the rhythm is sinus with atrial bigeminy and blocked APBs. The APBs are not conducted to the ventricles in this case because they come so soon after the previous beat that the AV node is still refractory.
194. Wolff-Parkinson-White pattern (indicated by a short PR interval, widened QRS, and notching or slurring at the beginning of the QRS [delta wave]). It is best seen here in lead II. The anatomic substrate is an atrioventricular bypass tract that preexcites the ventricles. Such patients are especially prone to the development of paroxysmal supraventricular tachycardia (PSVT) associated with reentry involving the bypass tract.
195. Yes. The peaked P waves and right axis deviation are consistent with right atrial and right ventricle overload due to pulmonary hypertension. Sinus tachycardia, delayed precordial transition zone, and nonspecific ST-T changes are also present.
196. Sinus rhythm with alternating 2:1 and 3:1 second-degree AV block. This type of conduction disturbance with multiple nonconducted P waves is sometimes referred to as *advanced second-degree block*. The patient had a pacemaker implanted.
197. Narrow-complex tachycardia with a ventricular rate of about 160/min. Notice the subtle atrial waves at twice that rate (e.g., in aV_L and V_1) with a sawtooth appearance in II; therefore this is atrial flutter with 2:1 conduction (block). It is commonly mistaken for sinus tachycardia or atrial tachycardia.
198. Sinus rhythm with first-degree AV block and left atrial abnormality. The major finding is diffuse but prominent ST depressions (I, II, aV_L , aV_F , V_2 to V_6) consistent with severe subendocardial ischemia. (Lead aV_R shows ST elevations.)
199. Sinus rhythm with prominent Q waves, ST elevations, and T wave inversions in II, III, and aV_F as well as T wave inversions in V_3 to V_6 . There is reduced R wave amplitude in V_5 and V_6 with relatively tall R waves in V_1 and V_2 . These findings are consistent with a recent extensive infero-postero-lateral/apical MI.
200. Sinus rhythm with ST segment depressions (consistent with ischemia, digitalis, etc.) followed abruptly by ventricular fibrillation initiated by an R-on-T type of VPB.